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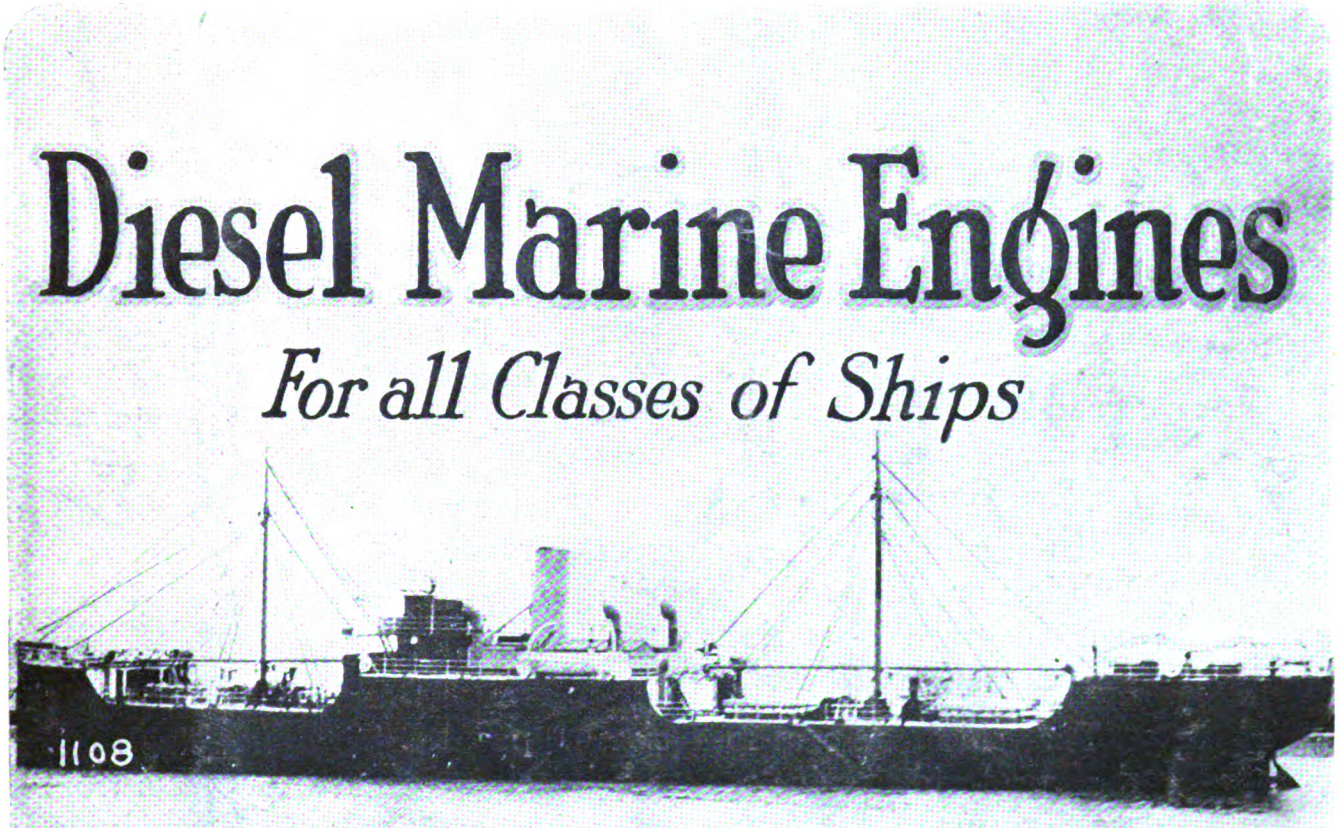
Diesel Marine Engines
For all Classes of Ships



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Voyages of a Converted Steamer

Interesting Record of the Single-Screw Motorship "Songvaar," One of Three Sister Steam-Vessels Converted to Diesel Power Seven Years Ago

By R. D. KARR

MANY references have appeared in the pages of "Motorship" regarding various steamers that have been converted to motor-power now numbering in excess of twenty, among the more noteworthy of which are the three sister single-screw 5,000 tons d.w.c. cargo-carriers built on the Clyde twelve years ago, and originally known as the "Chumpon," "Bandon" and "Pangan." These craft were the earliest of large conversions, the work having been completed in 1914, since when they have reguarly been plying the Atlantic and other oceans for seven years, making big profits to their owners, especially during the period when there was a scarcity of bottoms.

They were built as steamers by Barclay Curle & Co., Whiteinch, Glasgow, in 1909, and in order that their history may easily be traced by shipowners, we will give their "family tree" as follows:

Original Owner
East Asiatic Co.

Present Owners	**Second Owner**
S. O. Stray & Co.	Norwegian Government

"Songvaar," ex "Landvard," ex "Pangan"
"Songdal" ex "Folkvard" ex "Bandon"
"Songvand," ex "Lidvard," ex "Chumpon"

Present Dimensions

Deadweight capacity	5,000 tons
Net cargo-capacity	4,300 tons
Gross tonnage	2,462 tons
Net tonnage	2,172 tons
Under-deck tonnage (cubic)	3,145 tons
Classification	Highest Norwegian Veritas 1A1
Power	1,600 i.h.p.
Engine's speed	110 r.p.m.
Ship's speed (loaded)	9 knots
Daily fuel-consumption (loaded)	8 tons
No. cylinders, bore and stroke	Six 26⅜ in.x39⅜ in.
Type	Four-cycle, single-acting
Make	British Burmeister & Wain
Length (b.p.)	330 ft.
Breadth	47 ft.
Depth	28 ft.
Total No. of crew	29 officers, engineers and men

The crew of 29 men is represented by ten engineers, etc., in the machinery-space, fifteen on deck, and four in the galley, the firemen having been eliminated when the vessels were converted to Diesel power, with the exception of the man required for attending to the auxiliary donkey-boiler. Diesel-electric auxiliaries were not installed because the vessels were already equipped with steam deck-machinery and the attendent piping.

Burmeister & Wain Oil Engine Co. of Glasgow (now Harland & Wolff's Diesel Engine Dept.) were the constructors of the marine Diesel-engines of these ships, and the work of conversion was carried out by them under supervision of engineers from the Licensors of that name at Copenhagen, Denmark.

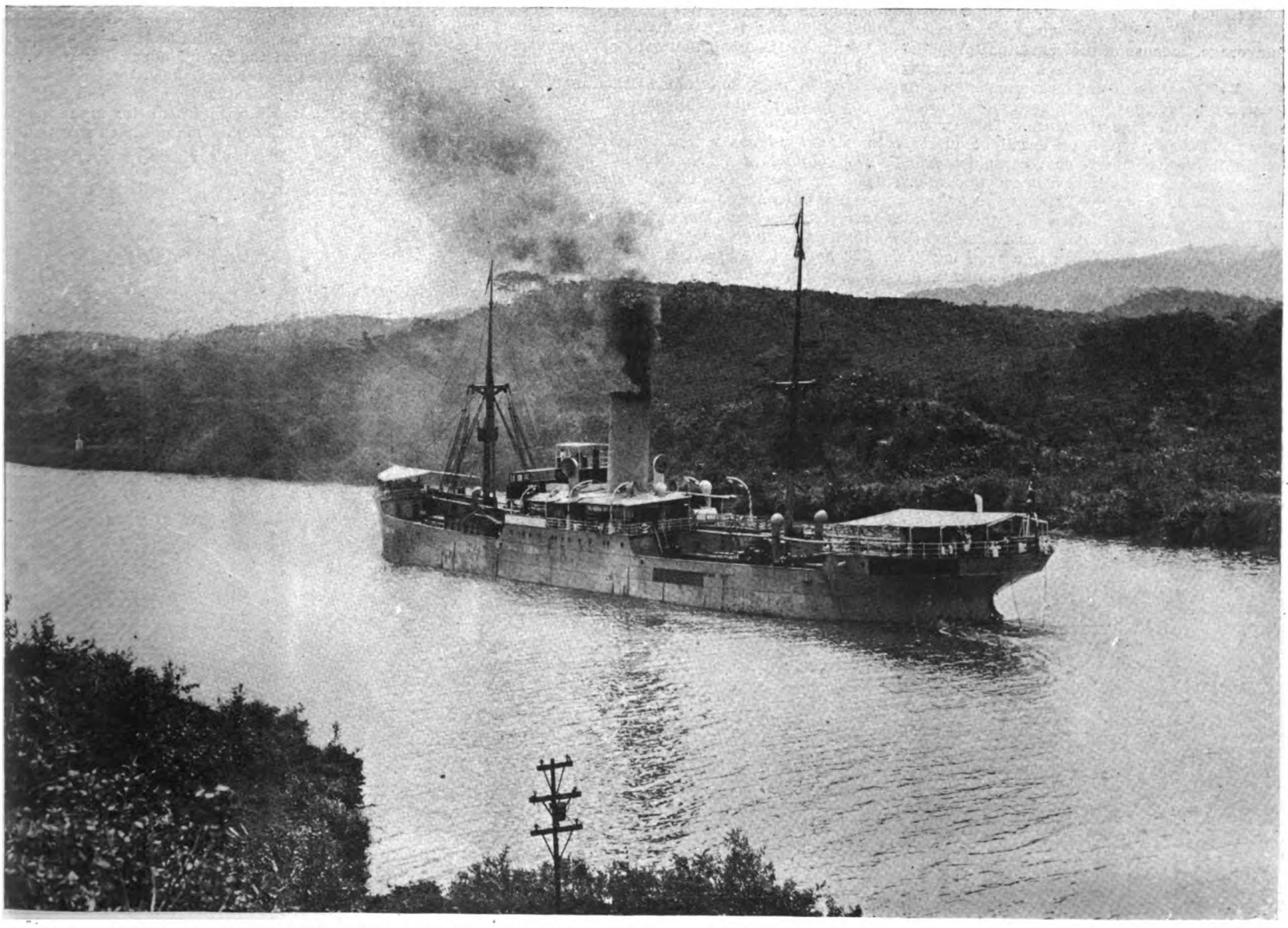

Fig. 1.—S. O. Stray & Co.'s motorship "Songdal," sister to the "Songvaar," in the Panama Canal. The smoke out of the stack is from the oil-fired donkey-boiler and not from her Diesel-engine

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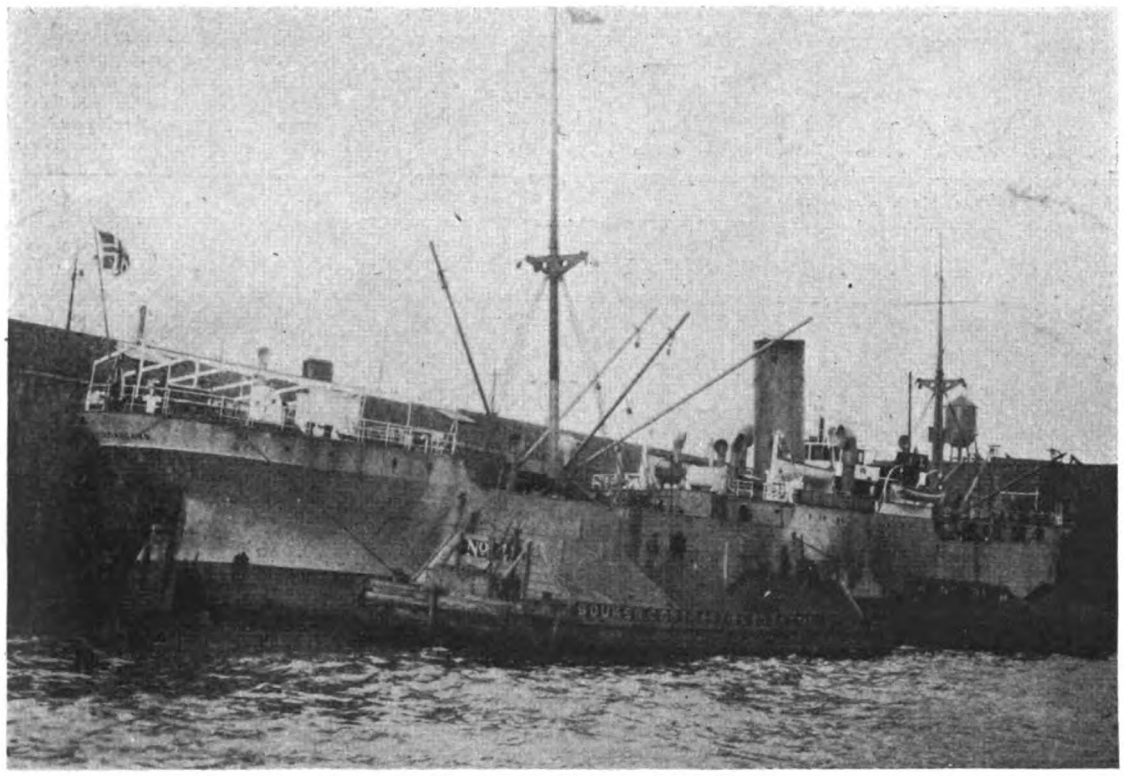

Fig. 2.—The converted steamship "Songvaar" at her pier in New York. She is now propelled by a single 1,600 i.h.p. Burmeister & Wain Diesel-engine

In their capacity as steamers before the conversion these ships may be considered to have been overpowered, being of 2,000 i.h.p. and burning 35 tons of coal per 24 hours, which from the point of commercial economy means too high a fuel-bill for a 5,000-ton ship. This is almost five times the present oil-consumption, and with less than one-knot difference in calm-weather speed, which as motorships, they should now "make up" over a year's average, because of the consistent propeller-efficiency in bad weather, due to absence of racing.

Originally these ships had accommodations for about twelve passengers in six staterooms on the starboard side in bridge structure. These rooms are now used for crew, giving excellent quarters with bath, hospital, messrooms, captain's cabin, etc., far in advance of the average accommodations in a similar-sized steamship. This point, however, is characteristic of the modern motorship—the attitude of all owners seemingly is to attract the higher class of dependable men to a seagoing life. That they have succeeded in most ships under foreign flags is becoming more and more evident. In fact, the way it works out in operation is this—a high standard of living is provided in accommodations, food, etc., and a correspondingly high standard of operating-efficiency is produced. This is now the aim of most American shipowners.

The work of conversion of the M/S "Songvaar," ex "Landvard," ex S/S "Pangan," was completed in 1914, as stated. She with her two sister ships were owned and operated by the East Asiatic Co. until the latter part of 1916, when these three vessels were sold to the Norwegian Government, who made a huge operating profit, and then sold them to S. O. Stray & Co.

Through the courtesy and co-operation of Mr. W. A. J. Kopp, Treasurer of S. O. Stray & Co. and Manager of the New York Office, and Captain Christopherson, the company's marine-superintendent, the writer obtained access to the ship's log-books and records since the beginning of operation by the Norwegian government in December, 1916. He takes the opportunity to acknowledge a debt of thanks to these gentlemen for enabling "Motorship" to place the following valuable operating information before shipowners.

Unfortunately, records of her performance as a steamship are not available, but even if they were, direct comparison would not be advisable, as the vessel was then higher-powered, carried a few passengers, and was in a totally different service from that for which records are at hand. But, undoubtedly, she now carries not less than 500 net-tons of cargo more than before.

At present all three vessels are owned and operated by the S. O. Stray SS. Co. of 11 Broadway, New York, and of Christiania, Norway, who are enthusiastic over their new tonnage. All three ships are in the Trans-Atlantic trade and will undoubtedly continue to "bring home the bacon" in the face of the coming rate-war, which era of economical-operation will serve perhaps more than the past war to bring into prominence the dependability and economics of the marine Diesel-engine. The ms. "Songvaar," of which the accompanying illustrations were obtained specially for "Motorship" and reproduced by permission of the owners, is now under charter to the Ward Line of New York, having left on New Year's Eve for Mexico with oil-well supplies and equipment. She arrived at the port of New York on December 14, 1920, in ballast—discharged, and went into dry-dock at Robins for cleaning and painting—proceeded to Pier 18, Brooklyn, loaded and sailed as stated above.

There are hundreds of steam-driven vessels laid up in the harbor—dozens of which the "Songvaar" passed and re-passed in two weeks on her busy way in and out through the Narrows. Were not the idle steamers seaworthy and ready for cargoes? Certainly! Could not the Ward Line use any of these vessels? We are reasonably sure that S. O. Stray & Co. chartered the vessel at a profit to themselves after paying crew, fuel and port charges. But, evidently, they are making a profit at a price for which American steam-vessels can not be operated. Perhaps it could be said the charter is not profitable! But we have to remember that the m.s. "Songvaar" crossed the Atlantic in a terrific mid-winter storm in ballast, to get this business. She probably would have stayed in Norway if her owners had not found profitable business for her here.

The "Songvaar" isn't the least bit different from a steamer in outward appearance, either from over the side or on deck. The steam cargo-gear, steering-gear, whistle, smoke-stock and rigging are all just as they were before conversion. Even when working the cargo smoke from her donkey-boilers pretty well smudges the atmosphere. The main machinery would perhaps give an unsuspecting steam-engineer a start when he first poked his head through the door in the upper engine casting "to look 'er over." If his glance should first take in the steering-engine, located in the upper deck level at the after end, he would have no intimation of the transformation elsewhere. This is still steam—and is located aft of the observer when viewing the main-engines as in Fig. 4. This picture shows the now generally familiar Burmeister and Wain cylinder-head arrangement. The first cylinder in the foreground is number five of the six cylinders for the whole engine, the last one being almost out of range of the camera, and is behind the engineers. Between the vertical air-suction pipes to the right may be seen the expansion-bend connecting the two halves of the exhaust-leader at the upper center of the engine. There are two one-piece castings for each group of three cylinders. Beyond the men may be seen the day service tanks, and on starboard side the donkey-boiler uptake.

Fig. 5 is a view looking forward on the port side at the operating-platform level. To the extreme left may be seen the steam generating-set—beyond a lathe and drill press. These tools are driven by belts from the shafting mounted overhead on the ship's frames. In the left foreground may be seen a work-bench and vise containing a fuel-valve—forward of the bench under the ladder is a small emergency air-compressor. This compressor is driven by a belt from the flywheel end of the steam generator in case of emergency. Beyond on the operating platform level may be discerned the auxiliary compressor. This is directly connected to a three-cylinder 200 h.p. 4-cyl. B. & W.

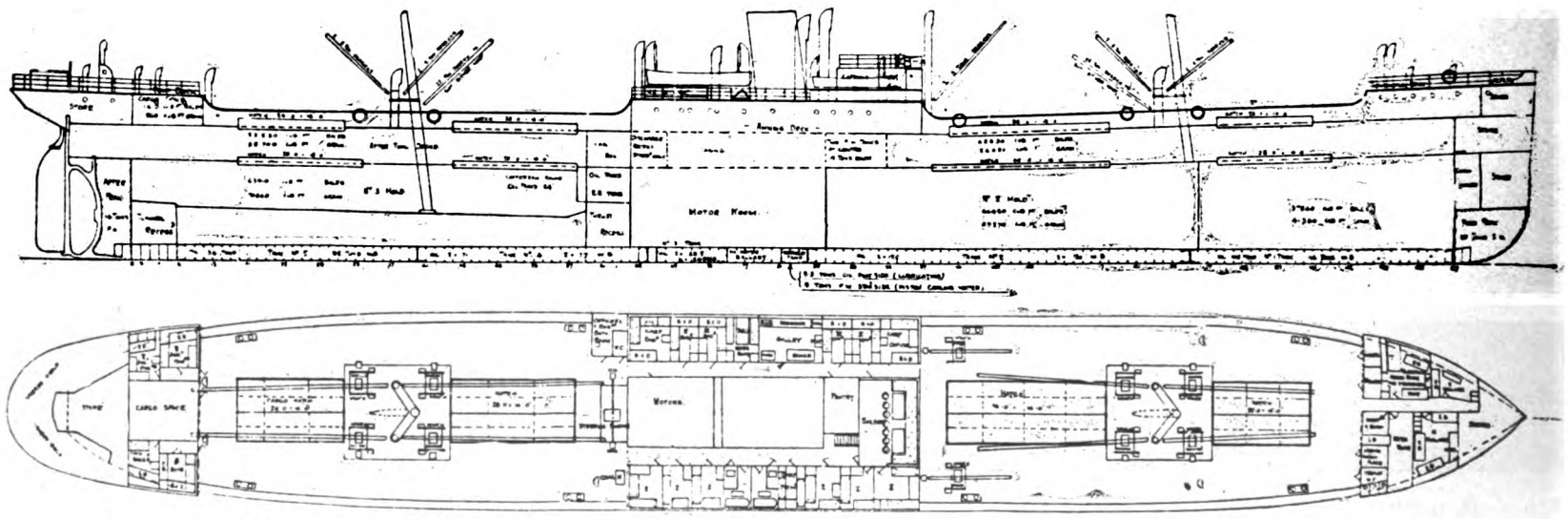

Fig. 3.—M.S. "Songvaar." Longitudinal section of hull showing small space now required for machinery and large cargo space

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Fig. 4.—M.S. "Songvaar." View of the engine-room looking down on the cylinder-heads. The three after cylinders can be seen behind the engineers

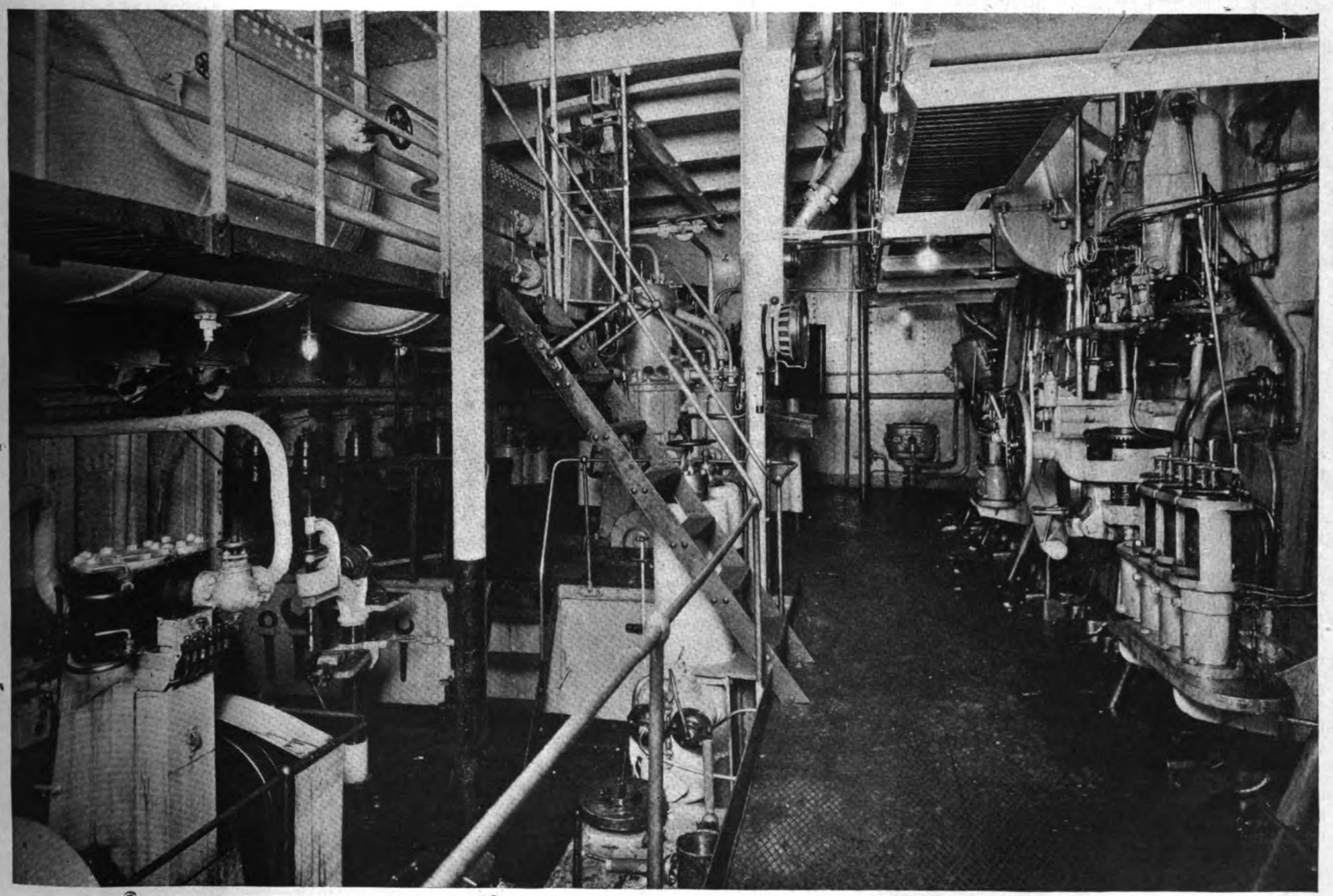

Fig. 5.—M.S. "Songvaar" looking forward on the port side of the operating platform of the engine-room

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Diesel-engine, running at 300 r.p.m. Overhead near the shell of the ship are the two manoeuvring air tanks, each about 5 ft. in diameter and 10 ft. long. There can be little said in describing the main engine details as visible to the right in the view shown. This arrangement has often been described, and as this engine has now seen six years of service the only comment that need be made is that one familiar with the later engines of this design will notice the improvement over this arrangement as far as simplicity and neatness of appearance. Essentially all of the characteristic controls and interlocking mechanisms have been retained in the more recent models. Thus we have a hopeful sign regarding the standardization of the marine Diesel-engine.

Proceeding to the starboard side of the engine-room we find the oil-fired donkey-boiler at the forward end, with two banks of auxiliary pumps, piping and manifolds. The boilers are the regular Scotch return-tube type, and are of British manufacture, as are all the pumps, etc. For giving the boiler

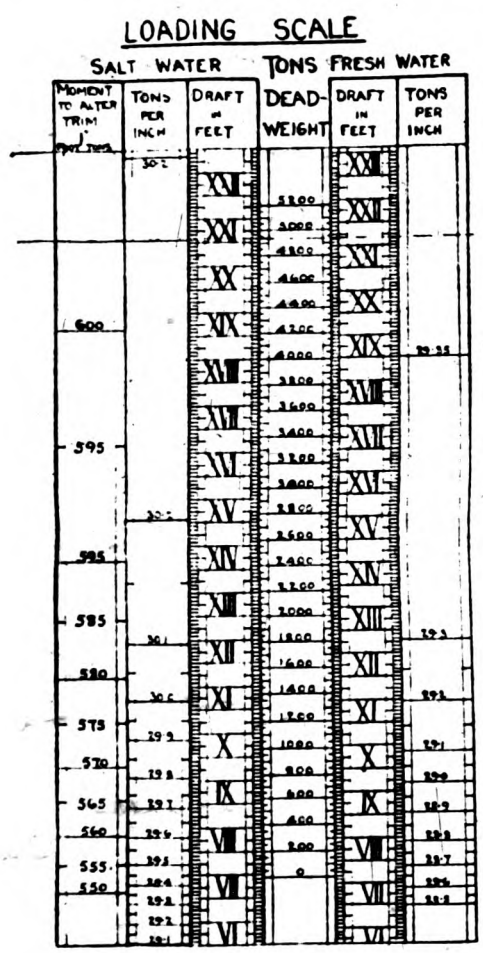

Fig. 6.—M.S. "Songvaar" loading scale

steam is used for atomizing the oil with the usual heaters, strainers, oil-pumps in duplicate. In the left of the picture (inboard side) are arranged the two engine fuel-oil transfer pumps, two lubricating oil-pumps, one distiller, one rotary fresh-water piston, cooling-pump and one centrifugal salt-water cyinder-jacket circulating-pump. On the outboard side are the bilge, ballast, general service, sanitary and wet-and-dry pumps—the latter for a cylindrical-shell single-pass condenser. In the illustration only the piping manifolds are in evidence.

A standard seven-collar thrust-bearing of the horseshoe type is located aft of the flywheel of the main engine with the usual oil and water service for lubrication and cooling.

Returning to a general discussion of the ship, inspection of the deck view will show the usual steam practice. The sizes of hatches may be mentioned as follows:

No. 1—22 ft. long x 13 ft. 11 in. wide
No. 2—36 ft. long x 13 ft. 11 in. wide
No. 3—28 ft. long x 13 ft. 11 in. wide
No. 4—24 ft. long x 13 ft. 11 in. wide

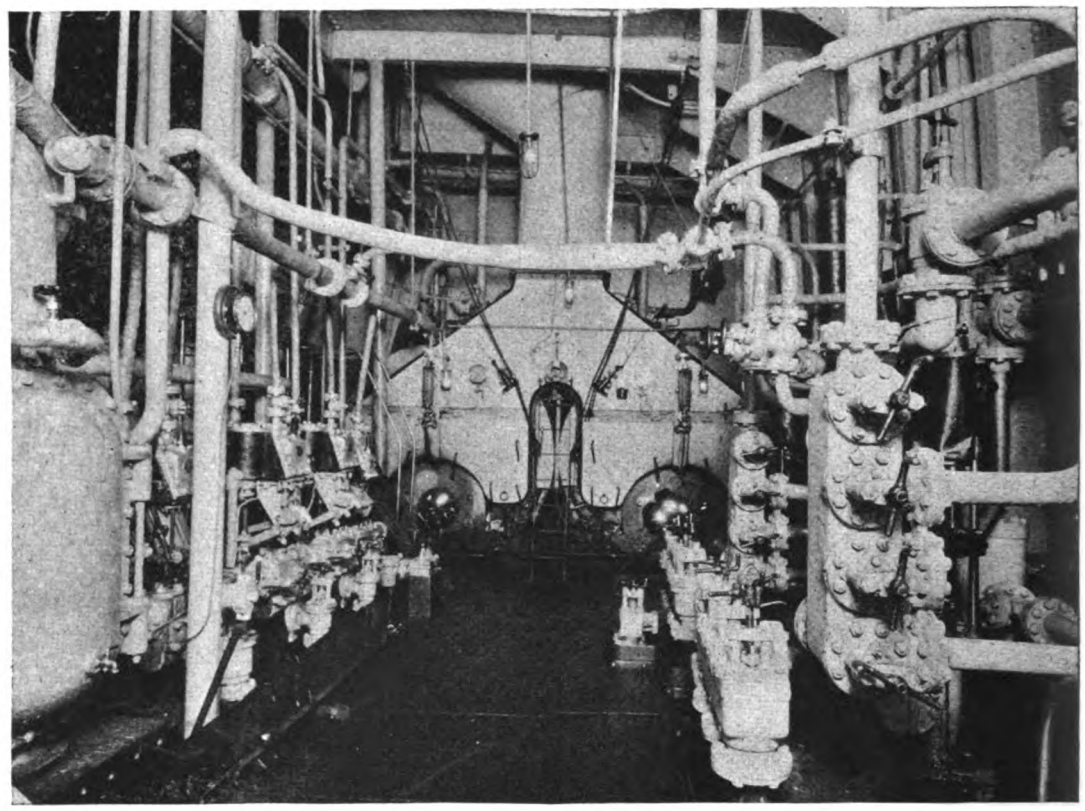

Fig. 7.—M.S. "Songvaar." Port side of engine-room showing oil-fired donkey-boiler at forward end

The ship has a double-bottom throughout which is divided as indicated in the following table of tank capacities:

Tank	Location	CAPACITY (Tons) Water Ballast	Fuel Oil
Fore peak—Stem to fr. No. 157		28	—
No. 1—DB.—Fr. 157 to fr. 127—Hold bld at fr. 128		114	105
No. 2—DB.—Fr. 127 to fr. 86 W.4.—Keelson—Hold bld. at fr. 86		260	240
Lub. Oil Tank—Frs. 81-84—Port side			8.5
Fresh-water (piston cooling)—Frs. 81-84—Star side			9.0
Dry well—Frs. 75 to 81 No. 3—DB.—Fr. 75-67 W.4—Vertical keel		49	45
Eng. Room sump.—Fr. 67-66			
No. 4—DB.—Fr. 66-40		154	142
No. 5—DB.—Frs. 40-13		92	84
Shaft-tunnel sump.—Frs. 13-8			
After peak—Frs. 13-0		14	
Hight tanks—Over-thrust recess		—	28
Day service tanks—Upper engine room		—	3.4
Total capacities		711	647.4

Above the thrust recess are two built-in fuel-tanks, the capacity of them being 3,433 gals. port, and 3,272 gals. starboard. In the upper engine-room the two settling-tanks for the main-engine fuel have a capacity of 7,400 kilos (1½ tons) each, and one tank for the auxiliary-compressor engine with 2,000 kilos (900 lbs.)

An analysis of the record of voyages made since the beginning of operation under the Norwegian Government in December, 1916, will be interesting. The adherence to steam auxiliaries has a marked effect in bringing up the total fuel-consumption as compared with the net main-engine consumption for each voyage.

Remarks on 4 years' service of M. S. "Songvaar":

Voyage No. 1.—Left Copenhagen 12/9/16. Cargo, 600 tons sand ballast. No stops. Weather fair. Arrived Philadelphia 12/30/16. Loaded at Philadelphia. Grain, 4,300 tons; fuel, 309 tons; lubricating oil, 12 tons; stores, etc., 60 tons; fresh water, 90 tons; total, 4,671 tons d.w. (W. N. A.) Stopped at Kirkwall, Great Britain, for inspection of neutrality February 2, 17. Left Kirkwall 2/1/17. Arrived in Bergen 2/9/17.

Voyage No. 2.—Discharged cargo and waited for orders on account of proclamation by Germany of unrestricted U-boat warfare.

Voyage No. 2.—Left Bergen 2/24/17 for Baltimore with 600 tons sand ballast, via Halifax, N. S., for inspection. Arrived at Halifax 3/16/17. Very bad weather. Left Hal 3/18/17. Arrived in Baltimore 3/23/17. No stops. Loaded 4,400 tons of grain and 360 tons fuel. No repairs. Left 3/31/17. Arrived Christiania 4/23/17. No stops. All rough weather. Discharged and went to shipyard of Akers Mek. Vaerksted, in Christiania for miscellaneous machinery over hauling and boilers repaired.

Voyage No. 3.—Left Christiania 5/27/17 in ballast, arrived Halifax for inspection 6/10/17. No stops. Left Halifax 6/11/17. Arrived in New York 6/15/17. Waited for cargo; took on 329 tons fuel, 9.7 tons lubricating oil. Sailed 7/4/17. Arrived in Halifax for inspection 7/7/17. Went aground en route to Halifax. Proceeded under own power. Received temporary repairs without drydocking, and left 8/6/17. Arrived in Sandfjord 8/20/17. Discharged cargo and went to drydock at Sandfjord. Extensive repairs to shell bottom plating, which was all crumpled; all fuel in double-bottoms was lost, but had 200 tons elsewhere, which was sufficient to cross the Atlantic. Shafting was realigned.

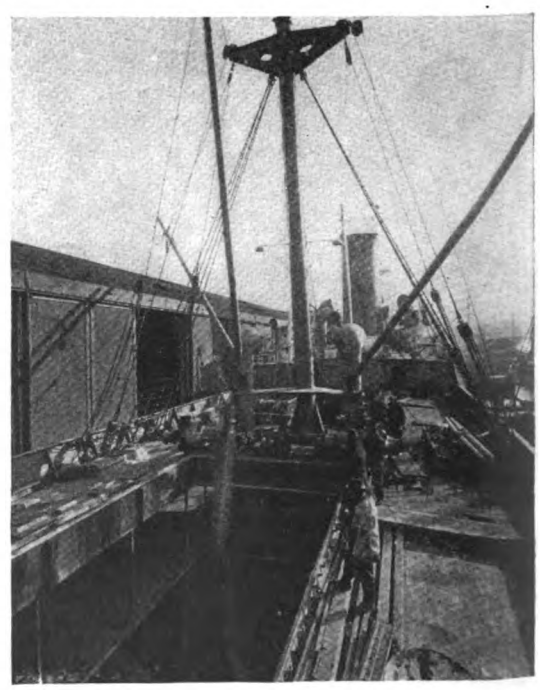

Fig. 8.—Deck of motorship "Songvaar" looking aft

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Voyage No. 4.—Left Sandfjord 12/22/17. Arrived in New York 1/17/18. No stops. 600 tons sand ballast. Waited for cargo. Sailed 3/21/18 for Newport News. Arrived 3/23/18. Loaded 4,637 tons coal; 343 tons in bunkers, stores and f. w.; total, 4,980 tons. Sailed for Habana 3/28/18. Arrived 4/2/18. Discharged cargo and sailed for Cardenas 4/5/18. Arrived Cardenas 4/6/18. Loaded sugar, 4,800 tons. Sailed 4/12/18. Arrived New York 4/17/18 and discharged. No stops. No repairs. Waited for general cargo. Loaded same and 447 tons fuel, 4 tons lubricating oil. Sailed 5/31/18. Arrived Moss, Norway, 6/18/18. No stops.

Voyage No. 5.—Left Moss for New York 6/26/18, in ballast, 600 tons sand. Stopped at Halifax for inspection 7/15/18, to 7/16/18. Arrived New York 7/19/18. Loaded general cargo. Left 7/31/18. Arrived Bergen 8/18/18. No stops. No repairs.

Voyage No. 6.—Sailed from Bergen 9/1/18, via Halifax for inspection. Arrived New York 9/22/18. Loaded general cargo. Sailed 10/6/18. Arrived Christiania, via Bergen, 11/3/18. Bad weather. Proceeded only by day in convoy along coast of Norway, anchoring in ports at night on account of mines in North Sea.

Voyage No. 7.—Sailed from Christiania 11/11/18 to Bergen, light. Loaded 700 tons sand ballast, and left for New York 11/22/18. Arrived New York 12/15/18. Bad weather. Had to go north of Scotland and close to Iceland to avoid war zone. Loaded general cargo, 4,000 tons (all cubic utilized), for Buenos Aires. Sailed 12/30/18. Arrived 1/28/19. No stops. Strike in Buenos Aires; idle 3½ months. Discharged. Loaded general cargo for Norway. Sailed 4/19/19. Arrived Christiania 5/27/19. Consumed two days running into Hull, England, for 300 tons fuel. Discharged cargo. Small repairs to engine.

Voyage No. 8.—Waited for cargo. Finally left Christiania 6/23/19 in ballast. Arrived New York 7/16/19. Took on 470 tons fuel in New York. Sailed for Gulfport, Miss., 7/18/19. Arrived 7/28/19. Loaded lumber, 1,100 standard, and sailed 8/21/19. Called at Port-au-Prince for 156 tons fuel-oil. Arrived Buenos Aires 9/20/19. Discharged and proceeded to Rosario 10/20/19. Arrived 10/22/19. Loaded 4,430 tons flour. Sailed 10/27/19. Arrived Christiansand, via Hull, 12/6/19. No unnecessary stops. Left Christiansand 12/9/19. Arrived Christiania 12/10/19, and discharged.

Voyage No. 9.—Sailed from Christiania 1/6/20 light, to Stavanger. Loaded 3,000 tons fertilizer. Arrived Bergen 1/9/20. Sailed 1/10/20. Arrived Charleston, N. C., 2/7/20. Very rough weather. Bunkered 350 tons fuel at Halifax, N. S. No stops. Waited for berth. Discharged and sailed, light, on 3/5/20. Arrived Louisberg, Canada, via New York, for stores 3/15/20. Lay off Louisberg 2 days for smooth weather. Loaded coal and sailed 3/23/20 for Christiania. Arrived Christiania 4/7/20. Discharged and went to Stavanger for drydocking and refitting. The ship had been sold to S. O. Stray & Co., in February, 1920, and she was now thoroughly overhauled and reconditioned by the Government before delivery. She was in the shipyard from April 28, 1920, to Nov. 9, 1920. All interior joiner work in living quarters is new, all machinery and equipment reconditioned, and she is to-day a pretty ship, sound, well found and well manned. Her first voyage under the present ownership brought her to New York—leaving Stavangar November 11, 1920, in ballast. The machinery is reported as behaving with absolute reliability, and the writer saw no evidence of any repair-work under way as a result of the severe trip.

Operating Data—M. S. "Songvaar"

Voyage	Distance Nautical Miles	Main Engine hrs : min	Auxiliary Engine hrs : min	Hrs. Donkey Boiler Port	Hrs. Donkey Boiler Star	Electric Generator hrs : min	Fuel Consump. (Tons) Mn, Eng	Fuel Consump. (Tons) Total	Lubr. Oil Consump. (Kg)
1 Copenhagen								+294	+12,800
to Philadelphia..	...	524 : 53	16 : 00	524	358	528 : 00	—94.6	—175	—520
Philadelphia									
to Kirkwall.....	...	405 : 00	4 : 00	329	193½	376 : 00	....	—141	—350
Kirkwall									
to Bergen.....	...	39 : 00	5 : 30	110	61	73 : 00	....	—19½	—39
2 Bergen via Halifax									
to Baltimore....	...	600 : 55	24 : 30	187½	984½	523 : 30	—91	—223	—559½
Baltimore								+360	
to Moss.....	...	480 : 28	10 : 20	1	510	303 : 30	—111.4	—179	—459
3 Moss via Halifax									
to New York....	...	421 : 05	16 : 30	314	441	216 : 00	—71.6	—145	—422
New York								+329	+9.914
to Sandfjord....	...	423 : 40	11 : 00	606	573	632 : 00	—98.7	—188	—441
4 Sandfjord									+4.810
to New York....	...	560 : 26	27 : 00	859	437	728 : 00	—95.9	—185.2	—565
New York via Newport News									+7.115
to Havana.....	...	157 : 39	15 : 00	139	159	730 : 00	—31.7	—151.7	—298
Havana								+447	+4.216
to New York....	...	152 : 33	8 : 00	177	152	141 : 00	—30.8	—57.3	—139
New York	Figures include standing by in New York 4/17/18 to 5/31/18								
to Moss.....	...	433 : 12	17 : 15	583	656	551 : 00	—93.7	—176.8	—471
5 Moss									
to New York.. ..	...	484 : 41	1 : 30	661	101	219 : 00	—83.6	—148	—364
New York									+1650
to Bergen.....	3,407	426 : 30	2 : 30	121	675½	264 : 30	—87.3	—141.5	—300
6 Bergen to Christiania and N. Y..	4,240	521 : 15	8 : 00	636	185½	380: 00	—93	—167	—370
New York								+271.1	+1686
to Christiania...	3,460	481 : 30	12 : 00	190¼	713½	497 : 00	—105.7	—185.7	—333
7 Christiania									
to Bergen.....	3,430	583 : 15	6 : 00	709½	316¼	618 : 00	—89.7	—180.4	—389
and New York..								+453	+4,267
New York									
to Buenos Aires.	5,872	675 : 15	3 : 00	698¾	425¼	620 : 00	—158.1	—257.7	—470
Standing by in Harbor of B. A. 1/29/									
19 to 4/6/19....	...	4 : 30	4 : 30	9	605	462	....	—47	—81
Buenos Aires									
to Christiania...	7,183	863 : 30	12 : 00	676	140½	983	—199.3	—340	—659
Christiania									
to New York...	3,990	571 : 00	6 : 00	591	24	337	—102	—163	—376
New York									
to Gulfport.....	1,708	231 : 00	4 : 00	11	288	161	—44.6	—73.5	—163
At Gulfport 7/29/									
19 to 8/20/19...	...	0 : 35	1 : 00	50	716	185 : 00	....	—33	—55
Gulfport									
to Trinidad								+156.5	
and Buenos Aires	6,683	864 : 00	0 : 00	136	360	608 : 00	—194.5	—291	—613
Buenos Aires									
to Rosario.....	240	38 : 00	5 : 00	115	95	104 : 00	—105	—22.0	—110
Rosario									
to Hull	7,286	884 : 00	5 : 00	284	761	564 : 00	—198.7	—299.7	—627
and Christiansend								+329.2	
9 Christiansend									
to Stavanger and									+3,200
Bergen.....	...	64 : 00	8 : 00	834	287	545 : 00	—17.0	—94.0	—223
Bergen								—250	—463
to Charleston...	4,106	658 : 30	16 : 00	291	833	576 : 00	—143.5	+350	
At Charleston									
2/8/20 to 3/4/20	...	6 : 30	5 : 00	428	491	316 : 00	—1.8	—58	—149
Charleston									
to Louisburg....	1,664	210 : 00	4 : 00	566	717	146 : 00	—42.5	—71.5	—149
Louisburg									
to Christiania...	3.162	584 : 00	11 : 00	909	1068	334 : 00	—86.5	—153.5	—291
Went to Stavanger, drydocked for reconditioning—delivered to S. O. Stray & Co.									
10 Stavanger									
to New York...	4,246	731 : 00	92 : 00	402	748	655 : 00	—94.2	—231	—509

It has been interesting and in a sense remarkable to see the growth of the sea-going motorship fleet on the Seven Seas. Like a bit of leaven the achievements of the earlier successes—often garbled into "failures" by opposing forces—have attracted, then convinced, and finally led others to adopt them. More and more shipowners are "seeing the light," just as the present owners of these able little ships learned of those advantages first through observation and then during the war as agents and charterers of the three converted steamers owned by their Government. Now as a result of sane reasoning and the courage of their convictions they purchased and now own these three motorships—"Songvaar," "Songdal" and "Songvand." May their type increase! This company, by the way, owns and operates nine steamships totalling 26,350 d.w. tons, sixteen sailing-vessels totalling 45,635 tons d.w., and one auxiliary motor-vessel of 3,600 tons.

Perhaps we shall see the New York and Cuba Mail SS. Co. (Ward Line) evincing some little interest in the type of vessel which they have just chartered. We await with not a little interest.

FRANK C. MUNSON'S ADVICE

At the recent meeting of the Merchant Marine Association in Washington, Mr. Fields J. Pendleton asked Mr. Frank C. Munson, well-known New York shipowner, what remedies could be adopted to overcome higher operating costs in wages on American ships, because the laws stipulated that our vessels must carry 50 per cent more men and pay 50 per cent more wages than foreign ships. Mr. Munson replied that the U. S. should adopt a Diesel-engine program which should result in the saving of fuel and employment of fewer men.

OPERATION OF 2,250 TONS CONVERTED SAILING-SHIP

The old sailing-ship "Sophus Magdalon," 2,250 tons displacement, and 1,500 tons d.w.c. was converted to Diesel power a year ago by the Haugesunds Mek Verksted of Haugesunds, Norway, and a 500 shaft h.p. Polar two-cycle Diesel-engine installed. After about twelve months' operation, the machinery is in excellent condition, no trouble or stoppage having occurred. The fuel-consumption has worked out at 2.3 tons per 24-hour day, and the speed is 10½ knots light and 8½ knots loaded. The propeller is 2,760 mm. dia. by 2,000 mm. pitch and 245 mm. diameter, and is driven at 150 r.p.m.

SUBMARINE ENGINES IN MERCHANT SHIPS

One merchant-ship propelled by twin 800 b.h.p. submarine Diesel engines reduced in speed so as to develop 600 b.h.p. has covered over 17,000 nautical-miles without any stop or delay. We refer to the m.s. "Oweenee" which is Vickers-engined. Another and similar vessel—the "Circe Shell," has covered over 14,000 miles without mishap of any kind. Both are tankers converted from iron sailing ships.

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Nordberg 2000 B.H.P. Two Cycle Diesel Engine

New Carels-Type Four-Cylinder Engine With 500 b.h.p. Cylinder-Output Runs Tests.

IT has frequently been suggested that America has no factories truly capable of constructing high-powered merchant-ship Diesel engines, and that no large sets had been turned out. This is a fallacy that has existed partly because most of our biggest Diesel engineering works are a long way from the seaboard and consequently, shipping-men are unfamiliar with their output and capacities. We have just returned from the Middle West where we visited factories of various kinds, including three plants of considerable size, two of which have been engaged in Diesel engine construction for many years and the third is just starting on their first engine, and which for reasons shall be nameless for the time being.

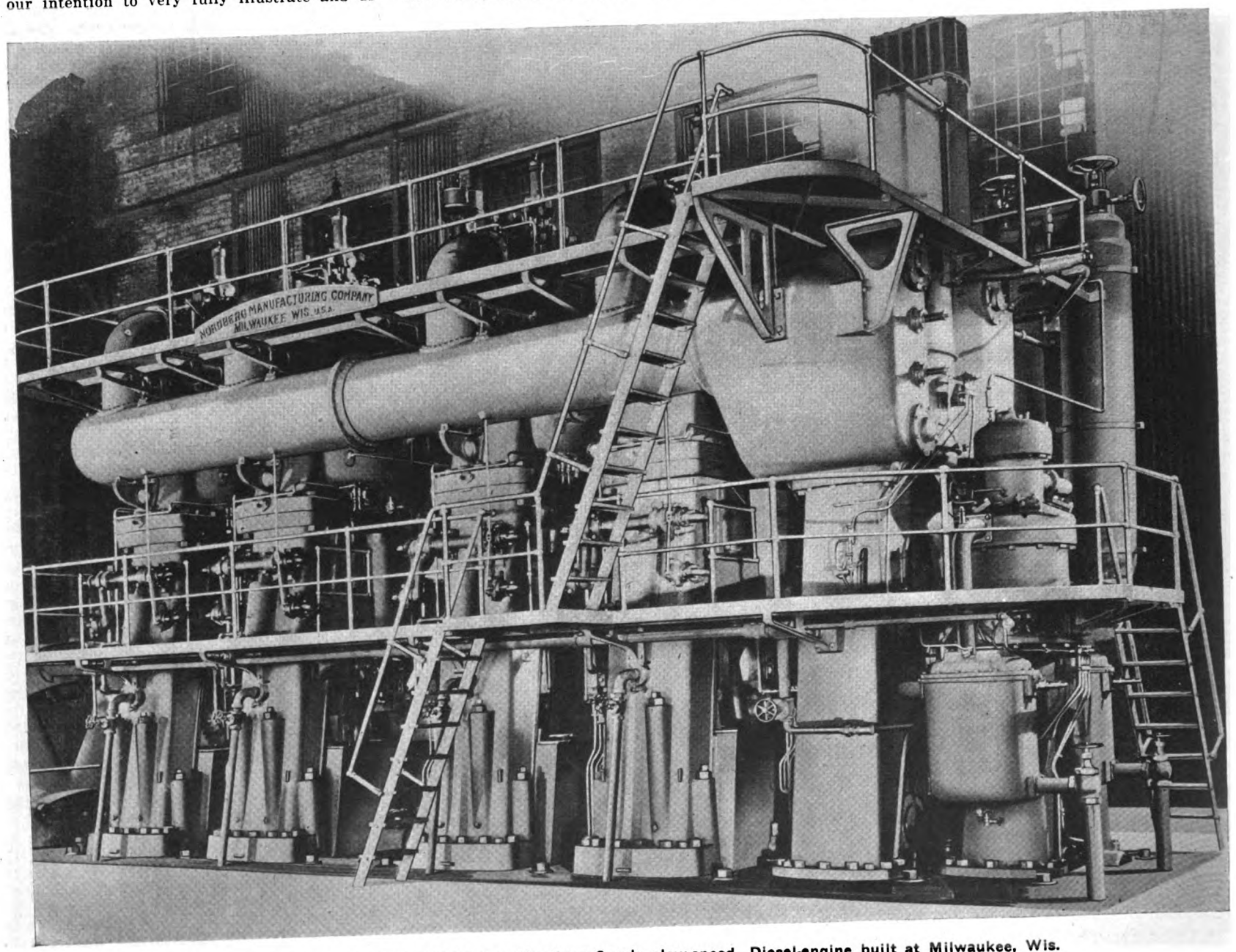
At one of the other two Diesel works, we saw the first of four crosshead-type Diesel-engines of 2,000 brake horse-power each running on the test-bed, and the same company's eighteenth 1,250 brake horse-power crosshead Diesel-engine start-up on her first run on the trial block, apart from five more and a number of smaller engines under various stages of construction. During our visit to Europe we saw most of the leading Diesel factories, and to be perfectly frank, we did not see one plant that could compare in capacity and equipment with this American one in the Middle West,—and, we saw some most excellently laid-out shops in Great Britain and in Continental Europe. The machine-shop alone of the American plant is eleven-hundred feet long, and the foundry is in proportion. Sometime during this year it is our intention to very fully illustrate and describe this and other Diesel factories in the United States in order that shipowners may become properly acquainted with their production facilities without making personal visits.

The particular Diesel plant in question that has completed so many big motors is the Nordberg Manufacturing Company of Milwaukee, Wis., who are constructing the well-known Carels Diesel-engine under license from Carels Frérès, Ghent, Belgium, who have engined a number of merchant ships, and who in conjunction with Schneider et Cie, of Creusot, in the past carried-out exhaustive experiments and developments including the building and testing of a single Diesel cylinder developing 1,250 b.h.p. This latter was quite a feat at the time as it was prior to 1912.

Unfortunately, for America's merchant-marine the 2,000 b.h.p. Nordberg-Carels Diesel-engine just completed and the three sister engines now building, are for land purposes and will be coupled to Westinghouse A. C. generators for providing power at the Phelps Dodge copper mines at Nacozari, Sonari. They will run on 14 Degrees Baumé Mexican crude-oil. Although they will not be installed in ships, we are giving illustrations and a few details, because the design is the same—with a few modifications—as the 2,000 shaft h.p. merchant-marine Diesel-engine that they have designed and which they hope shortly to commence building. Here it may be well to point-out that we were advised by the Nordberg Company that the construction of these large engines has now reached the stage in their plant that there is no necessity to carry-out prolonged tests on the brake at full-load and that the engines are run for comparatively short periods on light load without brake, then disembled and shipped to their destination, thousands of miles away, where they are re-erected and straight away put in regular service.

In addition to large numbers of Diesel engines, hundreds of steam-reciprocating marine-engines have been turned-out by them. So, with these ideal experiences, associated experiences and facilities, the Nordberg directors and engineers are quite confident that they can build high-powered slow-speed Diesel marine-engines which in operation in merchant-ships will give as near absolute reliability as can be expected from any class of machinery that is called upon to work under severe and consistent conditions year in and year out. In fact, they are to-day prepared to go ahead with ship's Diesel-engines of 3,000, 4,000 and 5,000 shaft h.p. each, and not only stand at the back of results; but, to give shipowners more than adequate guarantees of the necessary reliability and economy in advance. This with the full engineering realization that the task of constructing such big engines is not one to be handled lightly, nevertheless, with the confident knowledge that they and their facilities are fully equal to it. As regards workmanship, we would say that from what we saw at the Plant it would be a difficult task to find better, while the castings are excellent. The latter is one of the most important factors in Diesel-engine construction.

The 2,000 b.h.p. engine which we inspected is of the valve-in-head scavenging two-cycle type,



The four-cylinder, two-cycle type 2,000 b.h.p. Nordberg-Carels slow-speed Diesel-engine built at Milwaukee, Wis.

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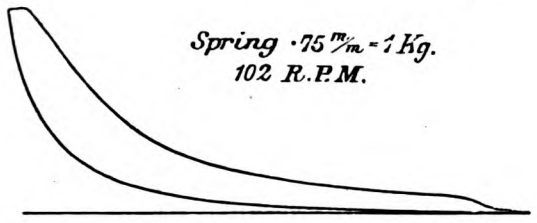
with vertical scavenging-pump and air-compressor driven off the forward end of the crankshaft, which by the way is built-up from Camden forged-steel sections and pressed together cold, the webs and the 17½ in. diameter crank-pin being in one piece forgings, with separate 17 in. diameter bearing-shaft forgings. The shaft-pins and the webs are turned and bored slightly taper respectively, and are keyed. They are pressed into position at a pressure of 150 tons, and afterwards the small square key is drilled-out and a large round key driven-in. This makes an enormously strong crank-shaft not liable to cracks or fractures. However, this is wandering into details of construction, instead of briefly describing the general features of the design of the engine as a whole.

This high-powered engine is only 40 ft. long, including a marine-type thrust-bearing, but without flywheel and is 22 ft. high above crank-shaft center to top of valve-rockers, with 12 ft. width over bed-plate. It has four-cylinders 28-inch bore by 44-inch piston-stroke, but the marine engine will have the stroke altered to 48-inch and so give the same power at 110 revs. per minute instead of 120 r.p.m. at which the stationary engine operates. It takes its place among the highest-powered four-cylinder Diesel engine yet completed

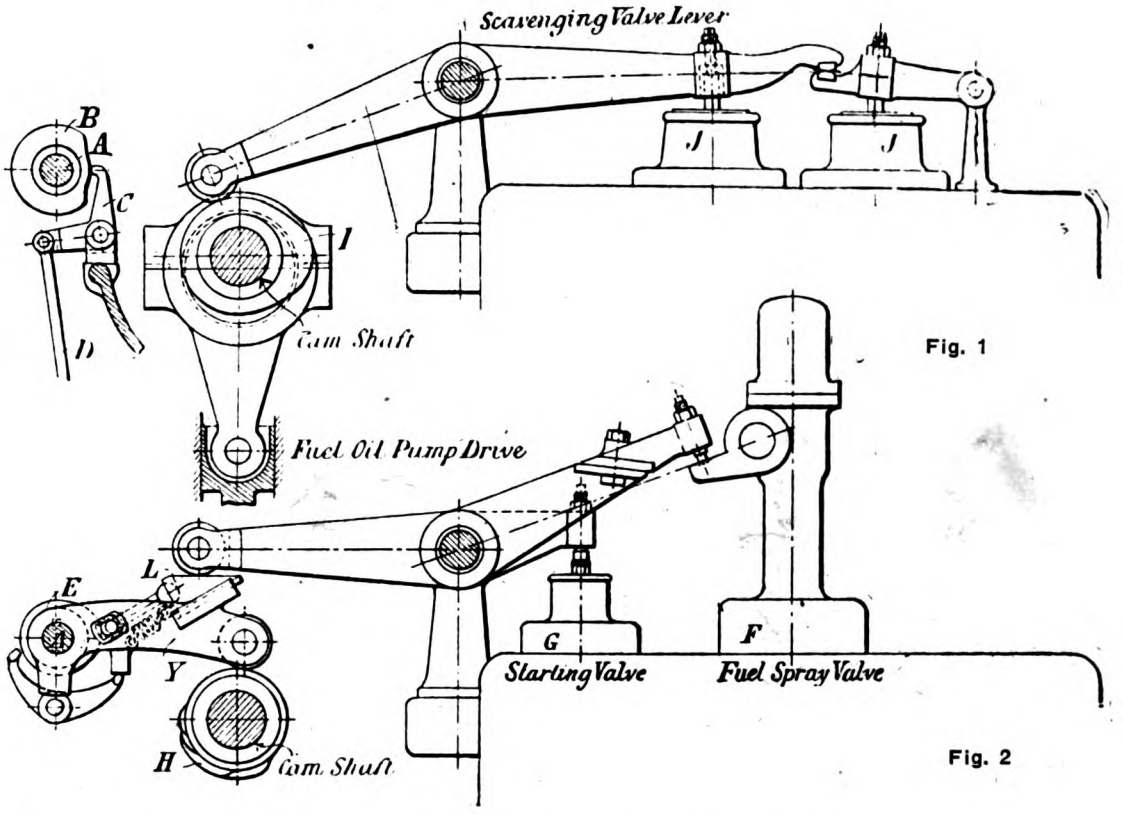


anywhere, if we except double-acting and opposed-piston motors. As far as a single-acting engine is concerned it is a noteworthy-accomplishment, and the accompanying illustrations and descriptions are the first to be published. This gives a cylinder out-put of 500 brake h.p. at 61.5 lbs. means effective-pressure and is higher powered than any other American Diesel engine yet built, even greater than the new Bethlehem-West engine which develops 2,500 b.h.p in six-cylinders—or 312 b.h.p. per cylinder. At it happens, it is understood that this latter engine is also of the valve-in-head scavenging two-cycle type, but no details are available.

Their respective weights, however, should make most interesting comparison, the Bethlehem-West

illustration. The cylinders are cast separately, and are directly mounted on cast-iron columns without any steel through-bolts—all stresses being borne by the columns. However, in the marine engine there is a cast-iron entablature between the cylinders and the columns to give the additional longitudinal stiffness required in a ship's

at the glands of the swinging-arms. Certainly we could see no sign of the slightest leakage on the engines in the Nordberg shops. Mr. B. F. Nordberg, Jr. said that troubles from leaks at the piston-cooling-water connections was the last thing they expected with a marine engine in service using salt water.



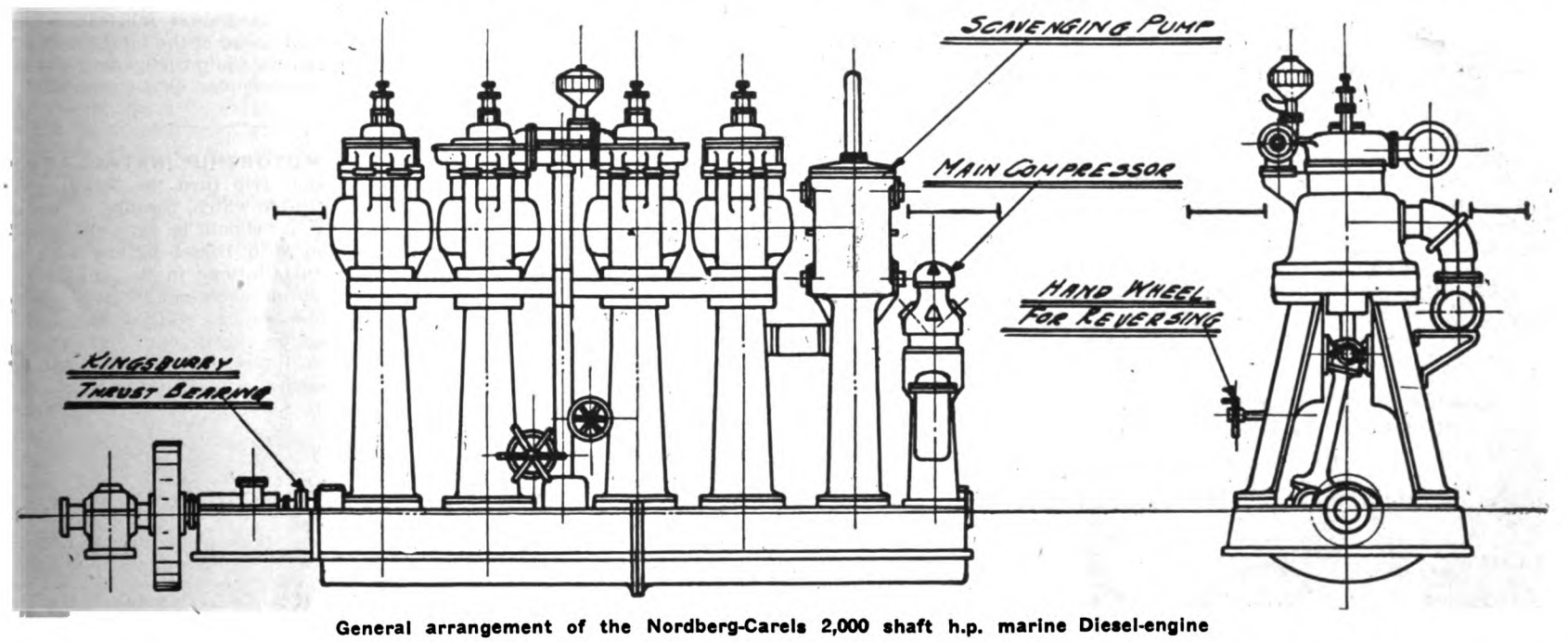
Reversing mechanism of Nordberg-Carels engine

installation. It will be seen that the design affords a walking space between the columns so that the engineers can easily pass from one side of the engine to the other, and can feel the cross-head and pistons, the latter extending below the cylinder liner on the down-stroke.

Cooling is by fresh-water for the land engines and by sea-water for the marine unit, the water

Another modification of the stationary design will be found in the bed-plate, which at present is in three sections and will be changed to two sections. The crank-shaft is in two sections, one for each pair of cylinders with the cranks at 180 degrees, one section being at 90 degrees to the other.

As regards the reversing mechanism for the



General arrangement of the Nordberg-Carels 2,000 shaft h.p. marine Diesel-engine

being 700,000 lbs. without equipment. The marine type of Nordberg-Carels 2,000 shaft h.p. engine weighs 630,000 lbs. or 315 lbs. per shaft h.p. This includes flywheel, thrust-bearing, air-bottles, piping, oil-filters and tanks—etc. or say under 300 lbs. per s.h.p. without equipment.

In appearance the Nordberg engine is very clean-cut and attractive, as will be noted from the

passing to the pistons through the crossheads by means of swinging arms. These arms have very large bearings and are of heavy construction generally. We were advised that the water used for cooling these engines in service at the copper mines contains a high percentage of acid, more deadly in effect than sea-water, but that they have not yet experienced any trouble with leaks

2,000 shaft h.p. marine engine, that will conform to the design already used on the machinery of Carels-engined motorships, with, of course, minor modifications to suit American-operating and manufacturing conditions, and with such improvements suggested by Nordberg marine-engine experiences. Control of the engine, by the way, can be handled from either deck of the gratings,

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a long vertical shaft having control-wheels on the level of each deck, so that the engineer-in-charge can stop the engine if he is on either grating, or on the floor of the engine-room.

Reference to figures 1 and 2, on the diagrammatical sketches of the valve-gear, will make the valve-gear and reversing and manoeuvring mechanism quite clear. There are two shafts running fore and aft and the cylinder heads, and supported by brackets to the cylinder-body in the usual way. The outer shaft (A) is the manoeuvring shaft, and to it are keyed, firstly, cams (B) for operating the fuel-pump's suction—valves by means of the bell-crank lever (C) rod (D), as seen in Fig. 1; and, secondly, the cams (E) in Fig. 2 which serve to regulate the lift of the fuel and starting air-valves (F) and (G) respectively, and also to lift and replace the inter-starting and inter-fuel levers from off the main cams (H). Loose upon this shaft there are one inter-starting and one inter-fuel levers (Y) for each cylinder.

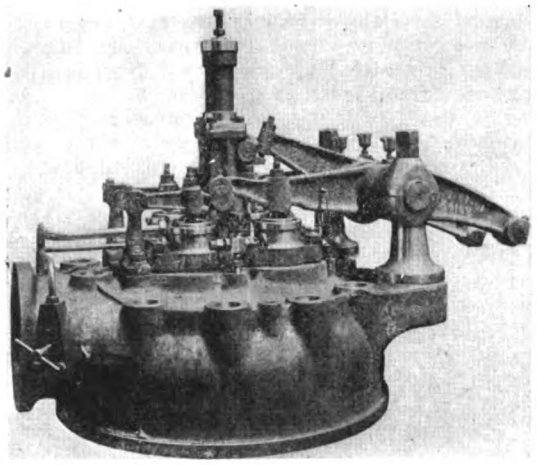
Turning now to a consideration of the reversing mechanism and its operation, there are two scavenging-cams, (I) operating the four scavenging-valves (J), and these are reversed by turning the cam-shaft through approximately 30 deg. by raising or lowering, as the case may be, the driving vertical-shaft by means of a compressed air servo-motor. In order to raise or lower this vertical shaft, the spiral-gears on the vertical-shaft are extra wide so that whether in the ahead or astern position, the proper tooth contact exists. By raising or lowering this vertical-shaft that it is compelled to rotate, due to the fact that the gears are spiral gears, therefore, the relative position of the main engine-shaft and the cam-shaft must be changed.

It must clearly be understood that the scavenging-cams do not move fore and aft. There are two fuel-cams and two starting air-cams to each cylinder, and the cams (E), by means of the roller-raising lever, lift the inter-starting and inter-fuel lever Y from off the cam upon which it has been working. Then the manoeuvring-shaft is moved longitudinally, and the inter-starting and inter-fuel lever is brought into line with the fuel or starting air-cam for the required direction of rotation. Further rotation of the manoeuvring-shaft rotating cams (E)—the inter-starting and inter-fuel-valve levers are loose upon this shaft—causes the inter-fuel and inter-starting air-levers, of bronze to descend upon the requisite cam.

Still further rotation of the manoeuvring-shaft and its cams E actuates the wedge-piece (L) through a roller and spindle, and so first causes the opening of the starting air-valve. Starting-air is thus admitted to all four cylinders, and then for two cylinders by a rotation of the manoeuvring shaft-cams, actuating now the wedge-piece (L), causes the starting-air to be gradually cut-out and the fuel to be gradually cut-in.

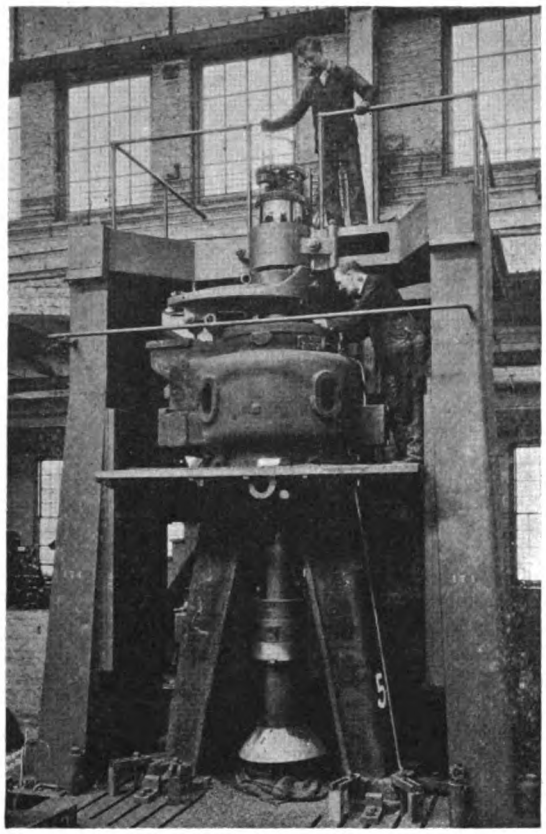
The fuel-pumps, one for each cylinder-are operated by eccentrics from the camshaft, and are arranged in pairs each pair operating in one forged-steel body, mounted between each set of two-cylinders on the upper gallery of the engine. At the same time as the fuel-oil is being cut-into the first two cylinders the cams shown at (B) operate through bell-crank levers, and so control the suction-valves of the fuel-pumps and fuel-oil is thus delivered to the cylinder. After the two cylinders are firing the further rotation of the manoeuvring-shaft causes exactly the same cycle for the other cylinders, and all cylinders will then be running on fuel.

The working of the valve-gear, the exact relationship between the cam-shaft, manoeuvring-



Head of a 500 b.h.p. Nordberg Carels cylinder showing scavenging-valves

shaft, and cam-levers, can well be understood from reference to the cuts attached. The action of the wedge-piece is obvious, and the spring which controls it is shown. It will be noticed that the fuel and starting-air cam-levers are in two pieces, to



Boring a Diesel cylinder at the Nordberg Plant with one of the many special machine-tools

facilitate the inspection of the valves. The scavenging air-valve gear is also clearly shown, and the manner in which the four scavenging-valves are operated will be readily understood.

A feature about this valve-gear is the wedging action whereby the starting-air is gradually cut out and the fuel-oil gradually cut-in. This gives an even turning moment all the time. At the commencement the air-pressure, viz., 400 lbs. to 450 lbs. per sq. in., ensures that there is a large starting torque; further, the design of the starting-valve mechanism necessarily gives that large starting torque at all positions of the cranks, and the wedge action makes for an even turning moment throughout the period of engine acceleration. There is no shock due to the air being suddenly cut-off and the fuel suddenly injected in. It is a gradual process the one merging into the other. The air for starting purposes, is reduced in pressure from the blast-air pressure to 400 or 450 lbs. by means of a reducing-valve. By reducing the blast pressure to 400 or 450 lbs. only one auxiliary air-compressor is necessary to perform all functions required in operation or manoeuvring.

The control of the engine is by means of one wheel and two levers on the starting platform; controls the servo-motor, which gives the cam-shaft its angular misplacement by raising or lowering the vertical driving shaft, and also gives the manoeuvring shaft its fore-and-aft movement. Another lever controls the fuel and also hand control is provided by a handle on the column, which actuates a shaft running fore-and-aft on the engine, and so sets all the fuel-pump suction-valves. A wheel operated by hand, gives the manoeuvring-shaft its rotary motion. As seen in Figs. 1 and 2, the cams upon the manoeuvring-shaft act upon the suction valves of the fuel-oil pump. The small dial above the hand wheel indicates the position of the valve-gear. Although compressed-air is used, as stated, for actuating the vertical shaft, causing the angular rotation of the camshaft and the longitudinal movement of the manoeuvring-shaft, the hand gear in emergency may be used. All of the manoeuvring levers are so interlocked that no false moves can be made.

By reading the foregoing description, at first thought, the valve gear may appear complicated, but this is not the case. It is true that it is composed of many parts but the function of each part is simple and definite. Stopping from full-speed ahead has on trial been accomplished in 2 to 3 revolutions of the main engines, and the reversals from full-speed ahead to full-speed astern has been accomplished in 6 seconds. In one case of a trial with a Carels-engined ship reversals were carried-out from orders given from the bridge of the vessel to correspond with the actual condition in service, and 63 reversals were accomplished in 42 minutes with more than half of the high-pressure compressed-air still unused. The auxiliary compressor was, of course, in use for this trial.

Finally, we will mention that when the first large Nordberg marine-engine is completed, we will give a very complete and detailed description in the pages of "Motorship"; meanwhile limiting ourselves to the foregoing brief description. We noted, by the way, that Manzel lubricators were fitted on this engine instead of the local make with which Nordberg used to equip their engines—Manzels now having been adopted as a standard.

A VALVE FOR MOTORSHIP INSTALLATIONS

When on a recent trip thru the Middle West we came across a valve which, because of its construction, to our mind should be very suitable for use in conjunction with Diesel-engines and auxiliaries, and for installations in the engine-room and other parts of merchant-motorships. Owing to shortage of time we are obliged to leave an illustrated description until our March issue. Meanwhile any firm interested can secure information by communicating with Mr. G. A. MacLean of the O'Malley Beare Valve Co. of 80 East Jackson Boulevard, Chicago, Ill.

Some Large American Diesel Engines Built or Under Construction

Engine Type	Bethlehem-West Two-Cycle	Worthington Four-Cycle	Nordberg-Carvels Two-Cycle	Mc Intosh & Seymour Four-Cycle	Busch-Sulzer Two-Cycle	Craig Four-Cycle	Ingersoll-Rand Four-Cycle	Skandia-Werkspoor Four-Cycle	Newport-News-Werkspoor Four-Cycle	New York-Werkspoor Four-Cycle
Brake horsepower	2,500	1,750	2,000	1,525	1,250	1,555	1,700	850	1,500	1,500
Indicated horsepower	3,500	2,400	2,800	2,000	1,800	2,000	2,200	1,150	1,950	1,950
No. of Cylinders	6	6	4	6	4	6	6	6	6	6
Cylinder Diameter	25½″	29″	28″	28″	24″	28″	....	20.472″	26.378″	26.378″
Piston Stroke	48″	46″	48′	48″	38″	48½″	....	35.433″	47.244″	47.244″
Revs. per minute	105	120	110	105	110	100	....	130	110	110
Piston Speed (per minute)	840′	920′	880	840′	696′	808′	....	767′	866′	866′
Brake H. P. per Cyl	416	291	500	254	312	258	....	141	250	250
Ind H P per Cyl	584	400	700	335	450	333	....	175	325	325
Weight (Short tons)	350 tons	339 tons	281 tons	361 tons	175	tons....	...	117 tons	201 tons	201 tons
Weight per B. H. P.	250	386	315	475	....	....	....	276	268	268
Mean Effec. Pressure	64.1 lbs.	73.27 lbs.	61.14 lbs.	65 lbs.	....	66 lbs.	....	....	....	....
Length Overall	....	45′	44′	47′–4¼″	35′	....	....	26′3″	34′	34″

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Motorship "Fritzoe" Runs Trials

Interesting 1,000 Tons D.W. Burmeister & Wain Diesel-engined Vessel for Baltic and North Sea Trades

PROBABLY shipowners on the Pacific Coast will be considerably interested in a new steel motorship of small tonnage which has just run successful trials in the firth of Christiania, Norway. She is a very complete and well-equipped vessel, especially built for transporting lumber to England, carrying coal as return cargo. Further more, her operation on this short route will be of considerable interest as some shipowners have been given an erroneous idea that motor-vessels can only be used advantageously on long overseas routes. They make excellent coastwise lumber carriers.

The vessel in question is the motorship "Fritzoe," which has already been referred to in the pages of "Motorship" and which must not be confused with the Götaverken-built Burmeister & Wain vessel "Fritiof" illustrated in the December issue of "Motorship." The latter vessel is a salvage ship.

The motor-freighter "Fritzoe" is a single deck ship with machinery installed aft. She has one large cargo hold with two big hatchways, the forward hatch being 33 ft. long by about 15 ft. breadth, while the aft one is slightly longer. Tanks numbers 1, 2, 3 and 4 are arranged to handle fuel-oil while tank 5 and the fore and aft big tanks carry 167 and 47 tons of water, respectively.

She is built to the Norwegian Veritas and has the following dimensions:

Dead-weight capacity	1,000 tons
Length (O.A.)	58 ft. 2 in.
Length (B. P.)	54 ft. 7 in.
Breadth (md.)	9 in.
Cubic-capacity (grain)	51,290
Cubic-capacity (bales)	46,424
No. officers and crew	16 men
Daily fuel consumption	1.9 tons
Loaded speed	10.0 knots
Trial speed	10.8 knots

The "Fritzoe" is propelled by a six-cylinder direct-reversible Burmeister & Wain four-cycle type Diesel engine of the trunk-piston class, and is of a new design especially built for service in small vessels. This reminds us that before the days of the "Selandia"—in 1910, if we remember rightly—Burmeister & Wain ran trials of a 400-h.p. trunk-piston type merchant-marine engine, which they built for experimental purposes prior to constructing the larger cross-head type engine of the "Selandia." The engine in the "Fritzoe" has a bore of 15.748 in. and a piston-stroke of 29.527 in.—the high stroke-to-bore ratio being with a view to securing as low a revolution speed as possible, thus enabling an efficient propeller to be adopted as the vessel has a single screw. At present the propeller is of cast iron with a diameter of 2.6 meters, but later on will be replaced by bronze propellers.

Burmeister & Wain have endeavored to secure a light engine without reducing the strength beyond that necessary for merchant-ship work with a machine of this power. Therefore, parts that have to stand heavy pressures are very strongly built, while the parts through which stresses do not pass are made as light as feasible. The cylinder-heads are bolted together, thus forming one rigid upper connection from which long tie-bolts are laid through the frame down to the main-bearings in the bed-plate, transmitting the pressure from the heads through these bolts into the main-bearings, with counter-balancing by the back-pressure from the crankshaft. Consequently, the cast-iron frame is released of all stresses and is only sufficiently rigid to withstand the tightening of the bolts and the side-thrust from the pistons.

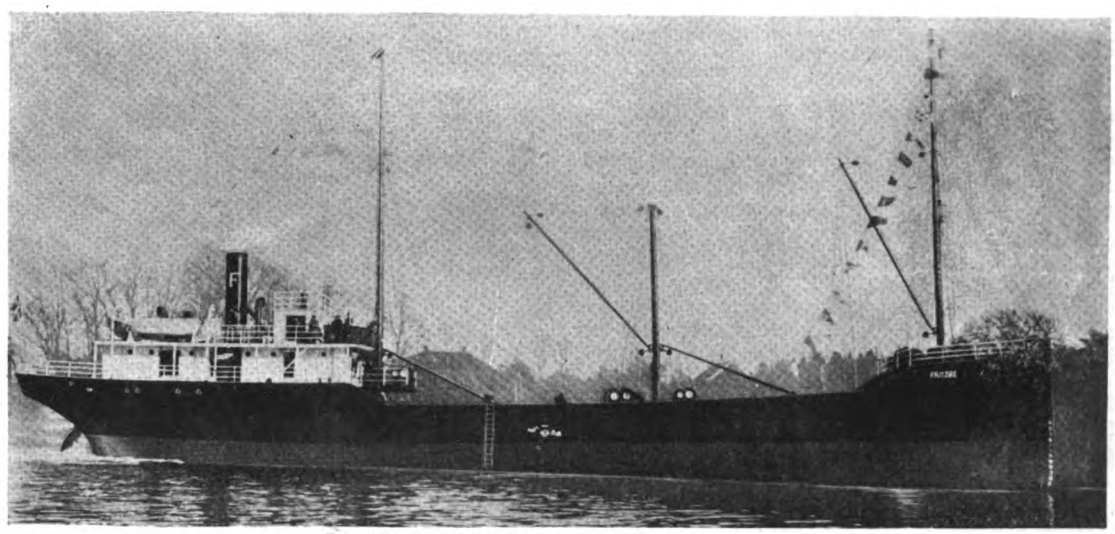
Regarding the cylinders, these have lightly pressed-on water jackets, and the liners are bolted to the lower side of the cylinder-heads. Both the liner and water-jackets are long because of the length of the piston stroke, and are made in decreasing thickness downways corresponding with the dropping pressure in the cylinder. This is possible because the liner does not have to transmit any power to the frame.

As is the general practice with Burmeister & Wain Diesel engine, force-feed lubrication is adopted, the engine being of the enclosed type with large inspection-doors, provided to the frames, through which the connecting-rods and the pistons can be removed. Attention has been paid to the design to having the center of gravity of the engine as far forward as possible, which is of importance in cases where the propelling-machinery is installed in the afterpart of the ship. For this reason the air-compressor—which is lighter than any of the working cylinders—is arranged at the aft part of the engine, while the fly-wheel is at the forward end contrary to usual practice. Also, at the forward end is the cam-shaft-drive mechanism, as well as the pumps which comprise a twin-cylinder cooling-water pump, a single-cylinder bilge-pump and a single-cylinder daily-consumption pump. All these pumps are driven from a common auxiliary crank-shaft driven in turn by gears from the crank-shaft, the gearing being enclosed and has forced lubrication.

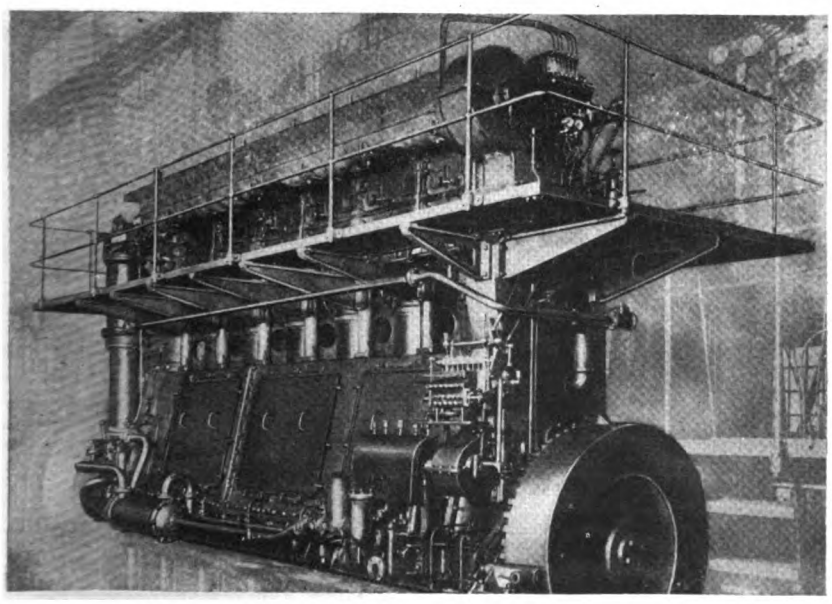
This propelling engine has a rating of 450 shaft h.p. at 145 revolutions per minute. On the test-bed the fuel-consumption worked-out at 177 k.g. per b.h.p. hour when using fuel of 10,000 cals. per k.g. At full power the engine consumes 1.9 tons in 24 hours. During the trial run of the ship this power was sufficient to give the vessel an average speed of 10.8 knots; so that 10 knots may be anticipated in service with the vessel fully loaded.

Shipowners should note that the fuel-capacity of 160 tons is sufficient for 80 days at full-speed, or a distance of 20,000 nautical-miles, which, while being a far greater radius than is required from a vessel in the service in the Baltic and North Sea, clearly shows that because of the economical consumption a small motorship can be employed with advantage on long routes as well as on short trips; whereas a steamship of the same size cannot be profitably employed in this capacity. This should increase the value of the ship.

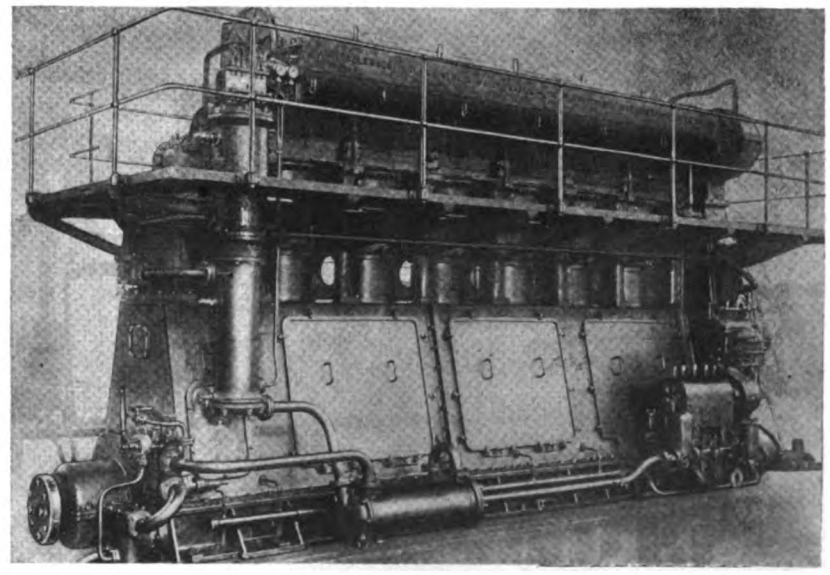
At the aft end of the engine there is a thrust-bearing of special twin-guided force-lubricated type, designed by Burmeister & Wain, while the stern-tube is provided with the well-known Cedervall stuffing-box. The maneuvering-levers are ar-



Danish Coastwise motorship "Fritzoe"



Port side of one of the Diesel-engines of the "Fritzoe"



Starboard side of one of the 450 b.h.p. Burmeister & Wain Diesel engines of the "Fritzoe"

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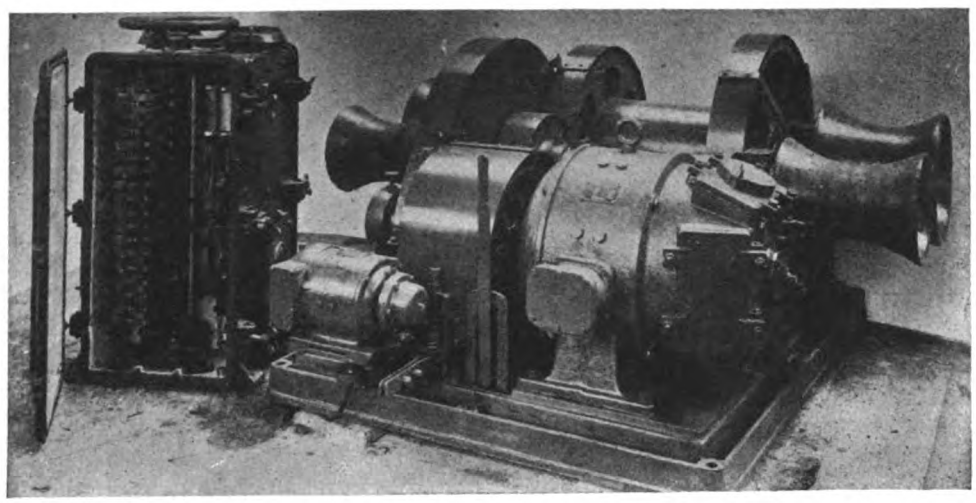


One of the electric cargo-winches of the motorship "Fritzoe"

ranged at a special "gallery" at the forward end of the engine.

For operating the auxiliary machinery there is a single-cylinder Burmeister & Wain Diesel engine specially built for small motorships. This engine is connected to an air-compressor by means of a clutch and is used for furnishing compressed-air for maneuvering the main-engines, and to act as a reserve compressor for the blast injection of the engine. Also connected to this Diesel engine by a clutch is a 33 k.w. 220-volt dynamo, and the current derived from this is used for operating the electric winches and deck. This auxiliary Diesel engine under normal conditions is only used when entering or leaving harbors and when loading and unloading in port. At sea a 6 b.h.p. surface-ignition oil-engine coupled to a small electric-generator is used for providing electric-light.

For service as ballast, bilge and deck-pump there is an electric-driven plunger pump of 20 cubic-meters per hour capacity built by the Eureka works of Christiania, Norway. Furthermore, there is an oil-fired boiler for steam-heating the cabins.

The m.s. "Fritzoe" is a two-masted vessel. A single Sampson post is provided amidships and there are four derricks, all three of which have a lifting capacity of 2½ tons each, while the fourth has a lift of 4 tons. These derricks are operated by four electric winches built by Titan of Copenhagen and are of the geared type with two speeds, the ratio of which can be changed by reclutching, so that fairly heavy lifts and fast speeds can be obtained with loads of 1¼ tons maximum weight.

The 4-ton winch is driven by a 220-volt 16 h.p. electric motor at 350 r.p.m. and gives the following speeds:

By Lift

4	tons	maximum	ratio	13,5	m. p. m.
0	"	"	"	26	"
1, 2	"	minimum	"	43, 5	"
0	"	"	"	86	"

By Veering

4	tons	maximum	ratio	35	m. p. m.
0	"	"	"	26	"
1, 2	"	minimum	"	115	"
0	"	"	"	86	"

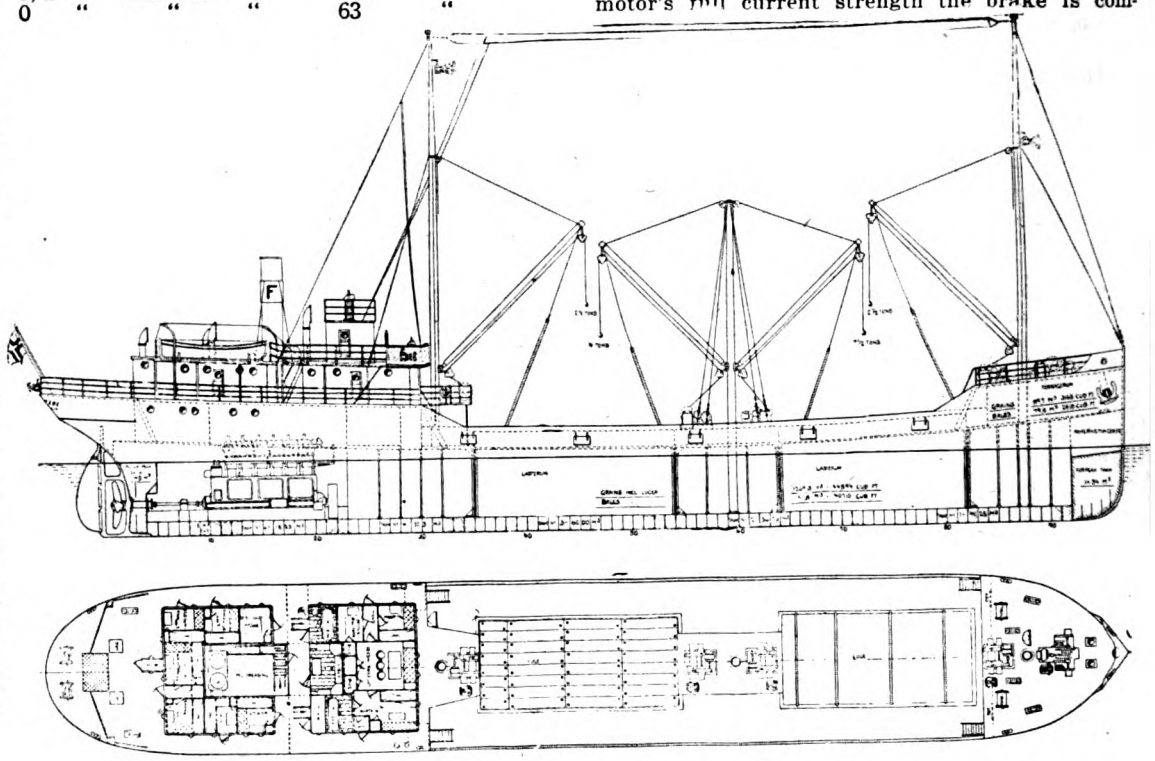
The 2½ tons winches are operated by 9,5 h.p. electric motors at 400 r.p.m. at the following speeds:

Lift

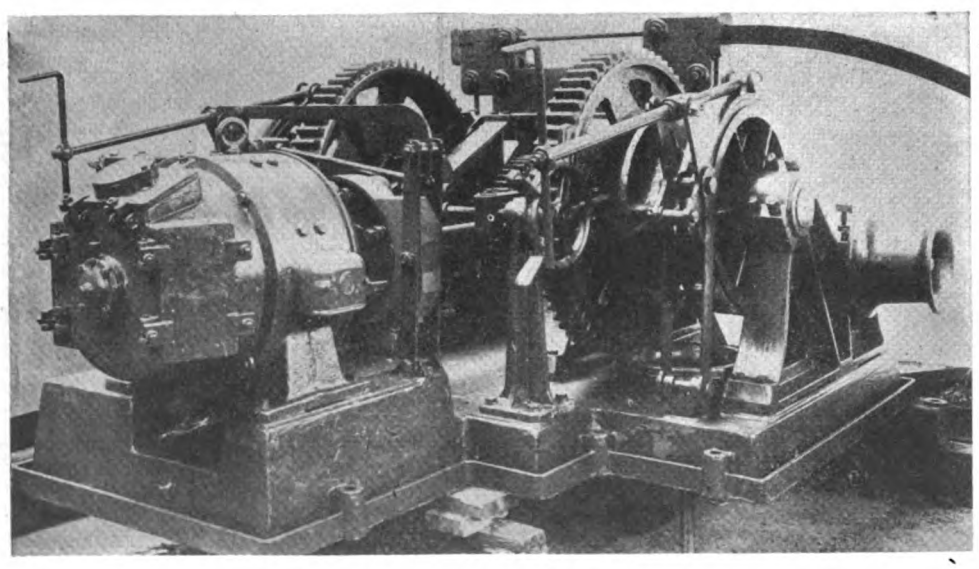
2½	tons	maximum	ratio	13,5	m. p. m.
0	"	"	"	30	"
1, 2	"	minimum	"	28	"
0	"	"	"	63	"

Veer

2½	tons	maximum	ratio	44	m. p. m.
0	"	"	"	30	"
1, 2	"	minimum	"	91	"
0	"	"	"	63	"



General arrangement drawing of the motorship "Fritzoe"



Electric windlass of motorship "Fritzoe"

The given speeds are attained in the last control position. The speeds can be regulated down with very wide range limits by means of the controller and an automatic electro-mechanic brake arrangement, patented by the maker. The electric-motors are together with the controllers and the resistances enclosed in common cast-iron boxes with watertight covers, so that the electric parts are amply protected against the heavy seas in the North Sea. Furthermore, the winches are raised somewhat above the deck by being mounted on a platform formed by the coaming that is lead through between the two hatchways. Through the cover there is easy access to the separate resistance and the controller of the symmetric-roller type with automatically closing maximum and minimum contact breaker. Both are arranged for mounting below deck, and the controller spindle is prolonged through the deck and through a manoevering pillar beside the winch to the control-wheel, the position of which is marked by an indicator on the pillar. The characteristic spring-loaded winch band-brake acts both as lock and for veering and is disengaged by means of a small seriesmotor, the anchor of which can only turn a fraction, and that is series connected with the main motor. When the latter is without current the brake-band presses against the disc. At all current strengths above one-third of the main motor's full current strength the brake is completely disengaged. If the current's strength drops by veering to below one-third of the full consumption of the main motor, the turning moment grows ultimately less than the moment from the brake-spring. Thus the band gradually tightens on the brake disc. In this way the strength of the current can sink to a certain minimum, corresponding to a certain maximum speed.

The electric windlass is arranged for a maximum load of 5 tons and a chain speed of 5.5 m.p.m. and is mounted on a cast-iron base-plate. The watertight motor is of 16 h.p. capacity at 220 volts at 800 r.p.m., and drives the two messenger-wheels through worm and twin-gear drive.

Regarding the crew of this vessel, there is a total of 16 officers, engineers and men, as follows: Captain, first and second officers, chief engineer, first engineer, one electrician, two oilers, one steward, one cook, five men and a boy. The quarters for both the officers and crew are arranged aft. In the two deck houses are,—saloon, captain's cabin, hospital, pantry, bath-room, galley, officers' mess cabins of the first and second mates, first and second engineers, steward and cook.

The builders of this interesting ship are the Nes Mechanical Works, Tonsberg, and she is owned by a shipowning company of similar name, but the management of the vessel is in the hands of Bugge & Olsen, Larvik.

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Marine Diesel Engine of 5,400 Shaft Horse-Power

New Design of Sulzer Two-Cycle Motor for Ocean-Liner Propulsion

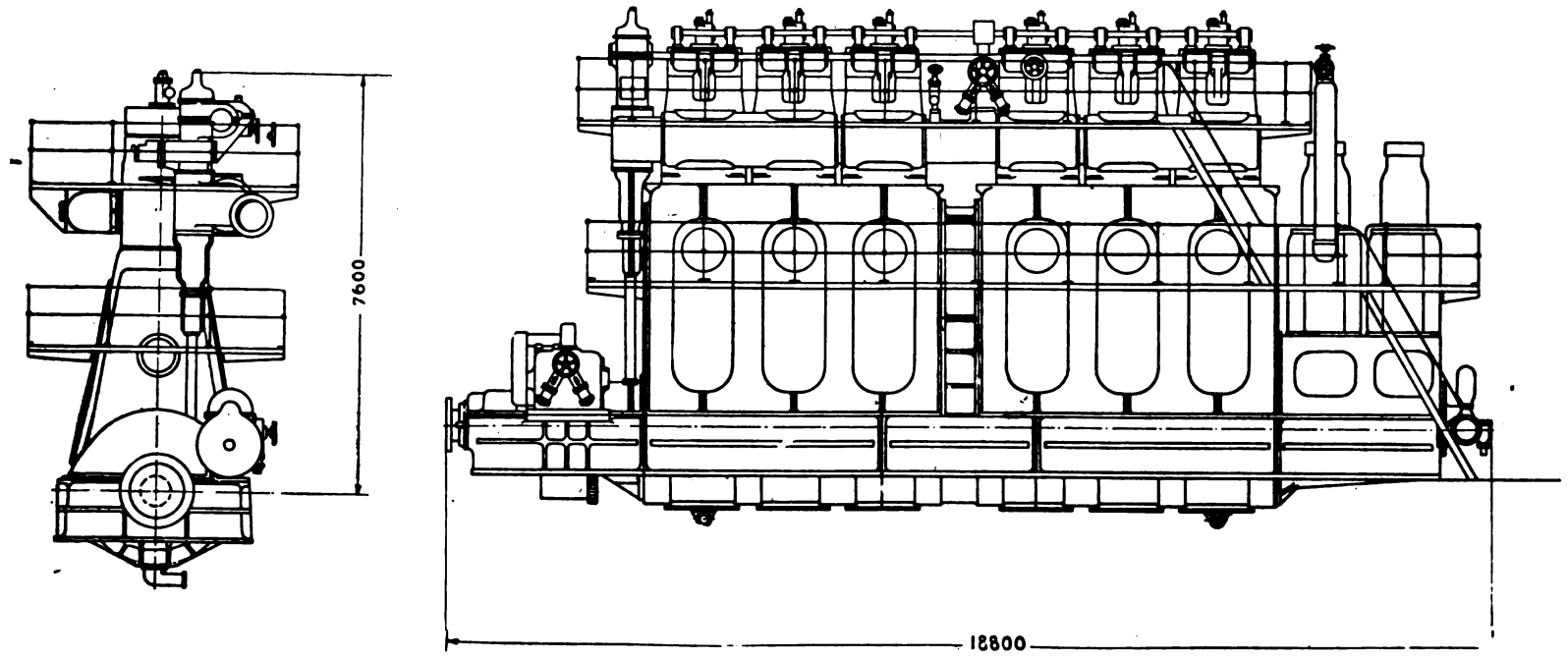
WITH a view to meeting the coming demand for moderate-sized, moderate-speed ocean passenger motor-liners that is being produced by the necessity of post war economies, Sulzer Freres, the well-known Swiss engineers have completed designs for a high-powered marine Diesel-engine of the slow-speed merchant type. In planning this big internal-combustion motor, they have the benefit of several years' operation of two six-cylinder two-cycle Diesel-engines of 4,000 effective horse-power each, one at Harland & Wolff's Belfast dry-dock, and one in France. Also to an extent, they have been aided by the design and construction of submarine-type Diesel-engines of 2,000 to 2,800 shaft h.p. (3,730 i.h.p.), and of 3,000 to 4,000 shaft h.p., the latter being for the Japanese navy.

Their new merchant-type Diesel-engine develops 5,400 shaft horse-power at 72 revs. per minute, or approximately equivalent to marine steam-engines of 6,250 ind. h.p. The dimensions of the engine should appeal to shipowners, as it allows of an engine-room of about 70 ft., the overall length of the engine, including thrust-bearing, being only 61 ft. 8½ in., with a total height of 37½ inches from crankshaft center. A twin-screw set will have an output of 10,800 shaft h.p. (or, say, 12,500 steam i.h.p.), on a total daily-consumption of 48 tons of oil-fuel at full speed. With this set a moderate-sized liner, such as the S.S. "New York" or the S.S. "St. Paul," would be given a speed of 16 to 17 knots, and would require only about 800 tons of fuel for a round-voyage from New York to Liverpool and return, including port-consumption. The small engine and bunker spaces, absence of boiler-room and elimination of firemen's accommodation and of boiler-water tankage, would greatly increase the passenger accommodations. Also, part of the latter would not be subject to undue heat, noise, smell and vibration, as are the passenger quarters near the machinery compartments of most steam-driven ships. Furthermore, there would be no smoke and cinders to annoy passengers on deck, so that there are advantages of comfort as well as of economics to be gained by the use of oil-engines for a propulsive medium.

A single-screw set would furnish adequate power for a modern combination passenger-cargo motorship of 14,000 tons d.w.c. and of 14 knots speed, or for a 14-knot 15,000 tons d.w.c. tanker, and with half the fuel-consumption of the motor passenger-liner. These types of vessels, with slight variations in tonnage and speeds, undoubtedly have great futures in overseas transportation.

This big Sulzer engine has six single-acting cylinders, each 35.433 in. (900 mm.) by 61.023 in. (1,550 mm.), and is of the direct-reversible type, following in general design, the Sulzer cargo-ship type Diesel-engines recently built. Scavenging is affected through ports in the cylinder-walls, and admission of the scavenge-air is controlled by a rotary-valve situated in the air-receiver. Instead of the scavenge-pumps usually fitted to two-cycle motors, the new system of turbo-blowers has been adopted, which arrangement was first described in "Motorship" of November, 1919, in the article on the Sulzer 1,250 shaft h.p. merchant-ship type engine. These turbo-blowers are driven by electric-motors that derive their current from dynamos driven by auxiliary Diesel-engines, so that at sea the full-power of the main-engines is available for driving the propeller-shafts. The current not required for the turbo-blowers when the ship is in port, is used for the electric cargo-winches and other auxiliary machinery on deck and in the engine-room.

Excepting for the turbo-blowers for the scavenging-air, the engine is self-contained and directly drives the pumps for cylinder and piston-cooling water, bilge-water, and lubricating-oil, as well as the two 3-stage compressors for supplying the injection and starting-air. The wheels for manoeuvring can be seen on the upper platform in the sketches. Starting and reversing are carried out as usual by hand and by servo-motors. It may be recorded that the engine can be started with air at a pressure of 25 to 15 atmospheres, or less. The constructional licensees in America are the Busch-Sulzer Diesel Engine Co. of St. Louis, Mo., who have completed many marine Diesel-engines for the U. S. Navy Dept., as well as many stationary-type four and two-cycle Diesel-engines.



Profile drawings of the Sulzer 5,400 shaft h.p. two-cycle type marine Diesel-engine designed for large passenger motor-liners and single-screw express-freighters

Oil-Engines for New York State Canal

Five 2,150 Ton Motor Barges

AFTER months of deliberation the Erie Canal Transportation Company, 42 Broadway, New York City, have decided upon installing oil-engines in the fleet of five grain-carrying barges which are to be built at the McDougall Duluth Shipbuilding Company, Duluth, Minn. Contracts have been let to the Skandia Pacific Oil-Engine Company of Oakland, Calif., through the medium of H. S. Johannsen, Eastern Agent, 25 W. 43rd St., New York, to supply the main and auxiliary motors for these vessels.

The Erie Canal Transportation Company is controlled by Julius Barnes, formerly chief of the U. S. Grain Administration who also controls the activities of the yards where the vessels are being built. Being confronted for years with the ever increasing railroad rates between Buffalo and the Atlantic seaboard and also with the diffculty of obtaining cars this company decided early in 1920 to inaugurate a line of barges to be operated on the Erie Canal to eliminte the rail haul from that point to Atlantic Coast points.

Questions of types of vessels and power were thoroughly discussed with the result that an altogether new class of canal barge —designed after sea-going practice—and propelled with its own power was decided upon. Because of the economy and the unusual demands upon the power plants of the vessels contemplated, a decision was made to use surface-ignition oil-engines of the Skandia-Pacific design. The barges will be 250 ft. in length, 36 ft. in breadth, with a draft of 10 ft. The displacement in fresh water will be 2,150 tons with a block co-efficient of 0.86 giving them a net tonnage of approximately 1,850 tons. The power plants are to consist of twin 140 b.h.p. four-cycle, direct reversible Skandia motors. The auxiliary equipment will consist of three single-cylinder, 16 b.h.p. Skandia stationary motors. Thus the oil engine power for the five barges totals ten 140 b.h.p. and fifteen 16 b.h.p. motors. A speed of 7 knots in open water is anticipated.

OUR REGISTRY OF SHIP'S ENGINEERS

Norman C. Rayner, unlimited license, has had extensive experiences in the installation of Diesel engines, also constructing and testing Diesel engines, and shop practice. Is a member of the M. E. B. A. 15 Whitehall St., New York City.

Carl Jensen, holds American license as Chief-Engineer for both steam and motorships, also Danish license as Chief-engineer for same. From 1908 to 1918 was with East Asiatic Company, five years of which were entirely with motorships. From 1918 to 1920 was employed by the Grace Steamship Lines of New York. Address 1032 Garden St., Hoboken, N. J.

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Standard Oil Co. of California's Second Motor Tanker

Diesel-Driven Vessel of 5,010 Tons D.W.C.

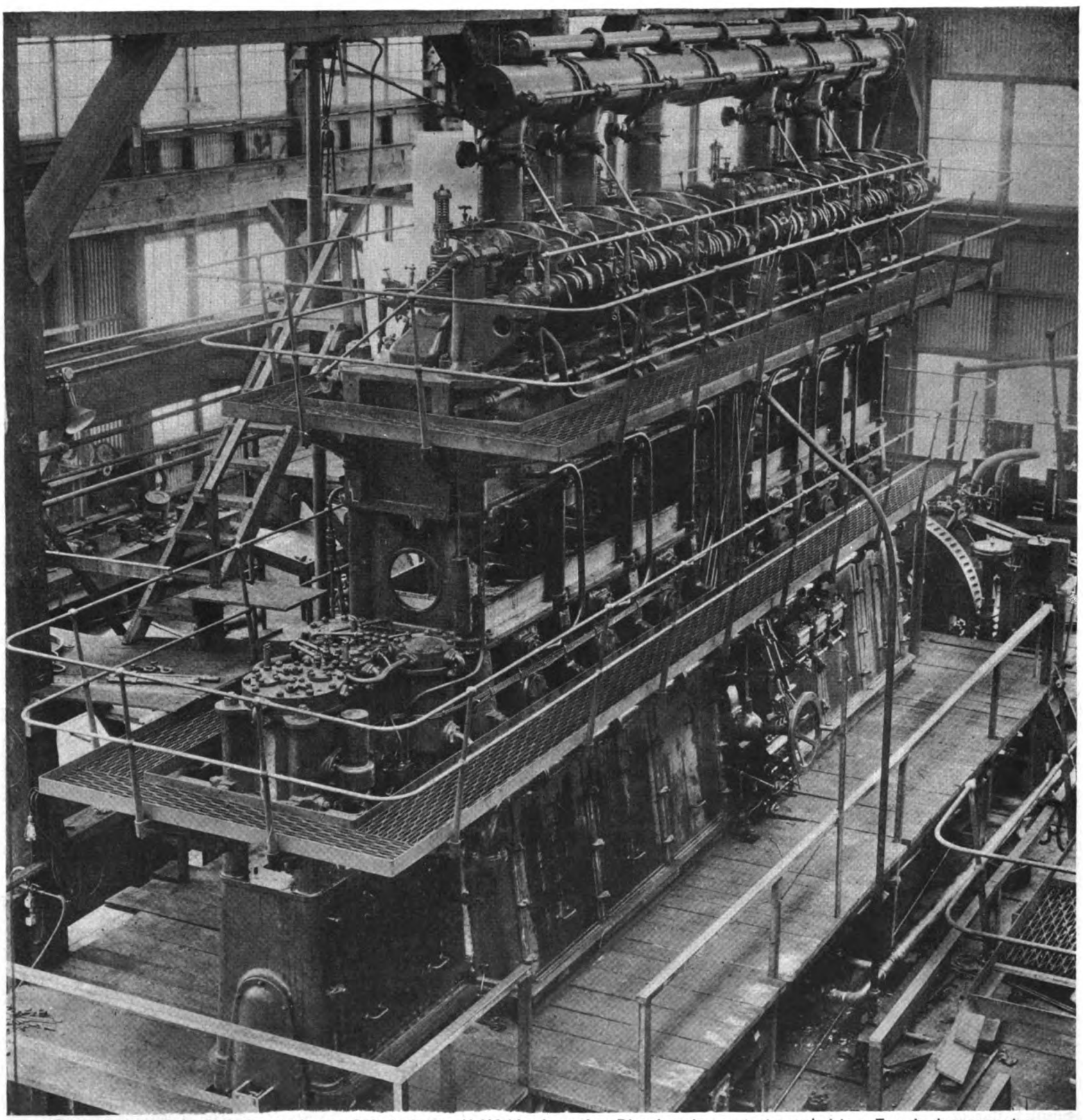
WHILE shipbuilding yards in general throughout the country are not working to capacity, the various steel shipbuilding companies located on San Francisco Bay are more favorably situated, each of the larger plants having on order several large contracts which will keep them busy for two years to come. An interesting feature of the shipbuilding in this region is the extent of the motorship construction. The latest one of these for which the keel has been laid down, is the tanker "F. H. Hillman," being built at the yards of the Moore Shipbuilding Company, Oakland, Calif., for the Standard Oil Company of the same State. This is the second motor-tanker ordered by this company from this region, and equipped with Skandia-Werkspoor 4-cycle Diesel motors built by the Skandia Pacific Oil Engine Company at Oakland, the first of the two having been illustrated and described in our January issue.

We have been able to obtain, from the owners, revised drawings and data of this latest vessel, which should prove of interest to our readers, many changes having been made since this vessel was originally described and illustrated in "Motorship" about a year ago.

The "F. H. Hillman" is a steel vessel, 342 ft. o.a., 330 ft. b.p., 46 ft. beam, and 27 ft. moulded depth to the spar deck, with a deadweight carrying-capacity of 5,010 tons on 21 ft. 6 in. draught. She is being powered with two 850 b.h.p. four-cycle Diesel-engines designed to give her a loaded speed of 11 knots, and is a steel twin-screw tanker of the spar-deck type, built on the transverse system of framing, with straight stem, elliptical stern. She will have three steel pole-masts, cargo-booms, Diesel-electric cargo handling gear and winches, and also electric steering-gear. A double bottom will be fitted under the machinery space; the deep-tank, piped for fuel-oil. The forward and after peak tanks will be fitted and piped for fresh-water.

The deck officers' quarters will be provided for in the bridge-house amidships, along with the wireless-room, the engineer's quarters, mess-room; while galley will be located in the deckhouse aft. The balance of the crew will be located in the quarters under the poop-deck aft. The main propelling-machinery, as well as all the necessary engine-room auxiliary, cargo pumps, deck winches and capstans, anchor-windlass and electric steering-gear will be supplied by the owners, and installed by the builders.

Owners of steam-driven tankers of similar dimensions to the "F. H. Hillman" should note that this vessel is designed to carry 4,350 tons of oil in the cargo tanks, together with 300 tons of fuel-oil in the double-bottom and deep tank; 50 tons of fresh-water in the after peak and fresh-water tanks and 25 tons lubricating-oil, on a mean draught 21 ft. 6 in. She is to trim 12 ft. by the stem, with all the main cargo-tanks full. Cargo space between the engine-room and the pump-room will be divided into seven main cargo-tanks and four wing-tanks, with a cofferdam at each end. A deep-tank and a



General view of the Skandia-Werkspoor 850 shaft h.p. (1,100 i.h.p.) marine Diesel-engine on test coupled to a Froude dynamometer.

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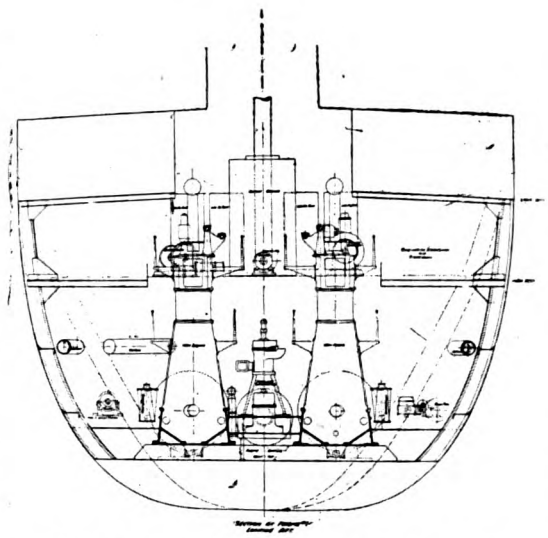
cargo-hold will be fitted forward between the pump-room and the collision bulk-head. Cofferdams are fitted between the engine-room and cargo-tanks, and between the cargo-tanks and pump-room, each of these being two frame spaces in length. A screen bulkhead will be installed in the pump-room to separate the motor-room from the pump-room.

A donkey-boiler will be located on a level with the main deck aft of the main engines. The electric steering-gear is located on the spar deck aft, directly over the rudder. For driving the electric-generator one 150 b.h.p. Dow four-cycle Diesel-engine and two 200 b.h.p. Diesel-engines of the same make will be installed in the engine-room, direct connected to one 100 k.w. 250 volt d.c. General Electric generators, respectively. The wireless motor will be located in a vapor-proof casing in the upper engine-room, with control to the wireless-room. The wireless is being constructed by the Radio Corporation of America. Propellers of the three blade, built-up type, designed by Rear Admiral Dyson, U.S.N., will be installed, and the propeller shafts will be 10 inches in diameter.

There will be three cargo-pumps of the Kinney type, each driven by a 90-h.p. General Electric enclosed motor. The cargo pumps will be controlled from controller room on the spar-deck, and will have its piping arranged as follows:

No. 1 suction-line to connect to tanks No. 1-2 and and 3; No. 2 suction line to connect to tanks 3-4 and 5; No. 3 suction-line to connect to tanks 5-6 and 7. Separate 6-inch suction branches will be fitted with 6-inch valves run to port and starboard tanks. Branches will be taken from the bottom of the 8-inch suction-lines and terminating in 8-inch bell-mouths located in the after end of each tank.

Discharge-lines will run up above deck to three fore and aft discharge-lines on after deck, fitted



Section at engine-room of motor-tanker "F. H. Hillman" looking aft

with gate-valves and discharge-nozzles. The three main suction and discharge lines are to be connected one to each of the three pumps, and cross connection provided in both suction and discharge side. Pumping will be arranged so that any or all pumps can draw from and discharge to any or all lines.

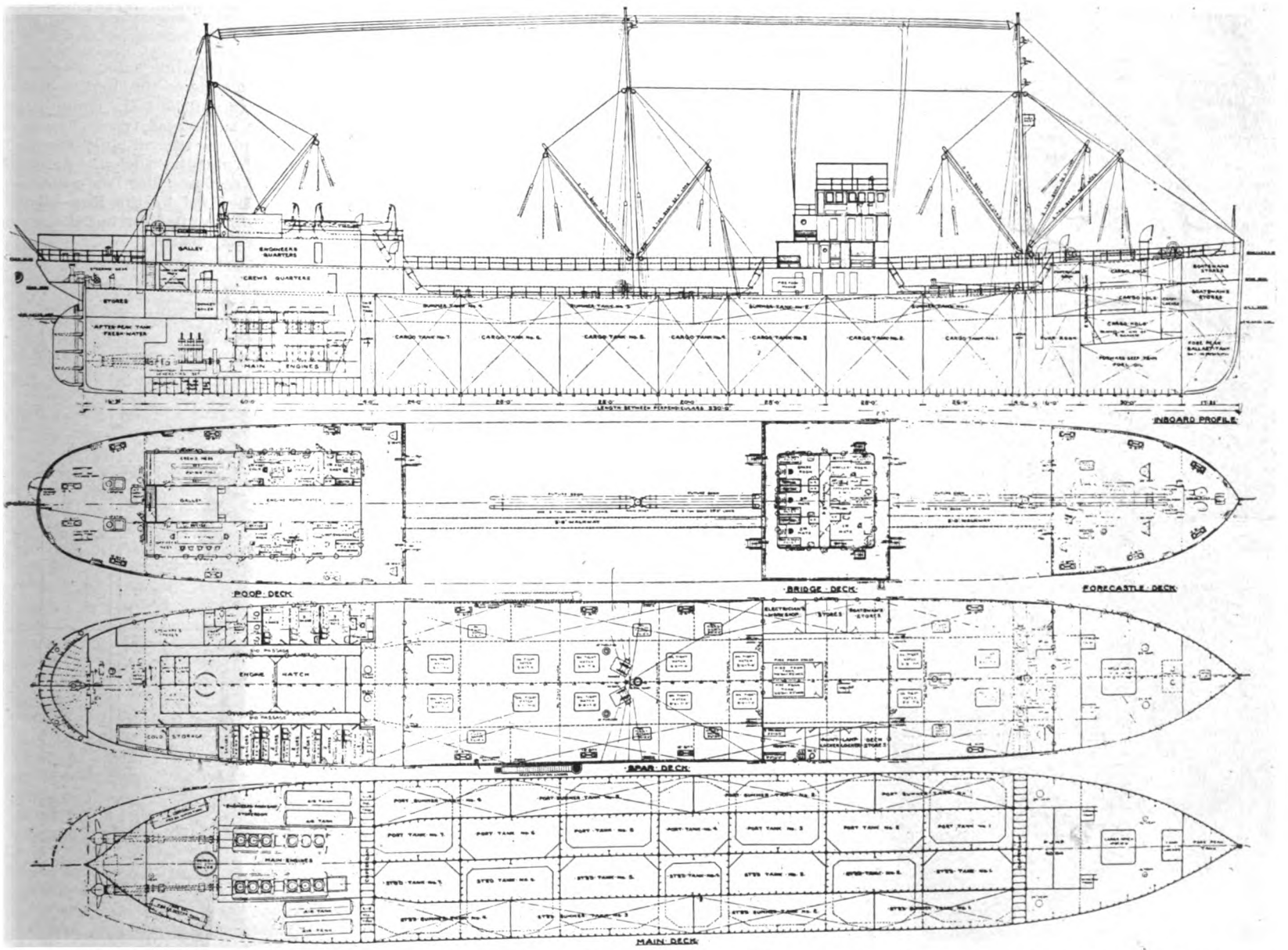
Eight-inch sea-suction will be fitted in each side of the ship, connected by athwartship line with branches to each cargo-pump, and with a 6-inch emergency bilge-suction, fitted with non-return valves. By-pass is to be fitted around the pumps to permit filling of cargo-tanks directly through the discharge and suction lines, without flooding pumps. A three-inch extra heavy galvanized-iron steaming-out line will run from the donkey-boiler forward, with 1½-inch branches to all main cargo-tanks and summer-tanks, also fore deep-tanks and cofferdams. Immediately under the main deck, piping is to be perforated to give the same area as the diameter of the pipe, for the purpose of using the same as a fire extinguisher in case of necessity. Provision will be made at the forward end of the poop, port and starboard, for shore steam-connection, to connect directly with the steaming-out line.

The arrangement of various pumps throughout the ship will be as follows:

There will be two motor-driven circulating-pumps arranged to draw from the sea through low suction on each side of the ship, and to discharge to the main engines and auxiliary circulating lines. Two motor-driven auxiliary circulating-pumps will be arranged to draw from sea and discharge directly to the auxiliary engines, lubricating-oil coolers, and filters, distiller, ice machine, auxiliary and booster compressor.

One Alsberger fire and bilge pump 3-stage type N., with a capacity of 300 gallons per minute direct-connected to a 40-h.p. General Electric motor will be arranged to draw from sea and bilges, with non-return valves to be fitted on the bilge suction, and will discharge to the firemain, sanitary system and overboard.

A 15-h.p. General Electric motor drives a two-stage Alsberger sanitary-pump, which is arranged to draw from sea and from circulating water overboard discharge from main engines, and to discharge to sanitary system, auxiliary circulating lines and donkey-boiler. Furthermore, there are two motor-driven bilge-pumps to draw from engine-room bilges and to discharge overboard.



Latest drawings of the Skandia-Werkspoor Diesel motor-tanker "F. H. Hillman." These show the changes since the original drawings in our April, 1920, issue were made

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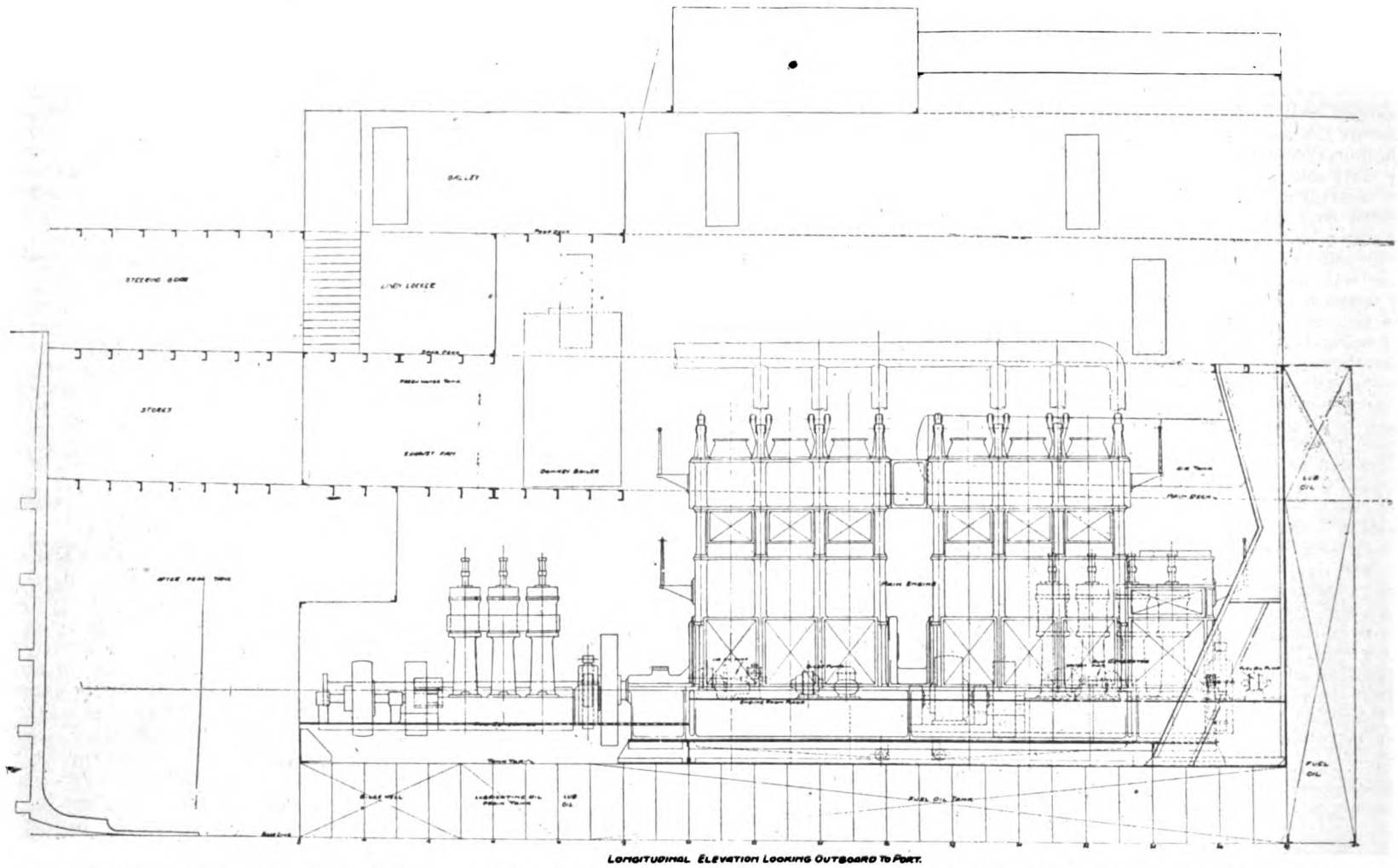


LONGITUDINAL ELEVATION LOOKING OUTBOARD TO PORT.

Longitudinal section of engine-room of motorship "F. H. Hillman," showing arrangement of Skandia-Werkspoor Diesel propelling-engines with the Dow Diesel auxiliary engines to port, starboard and aft

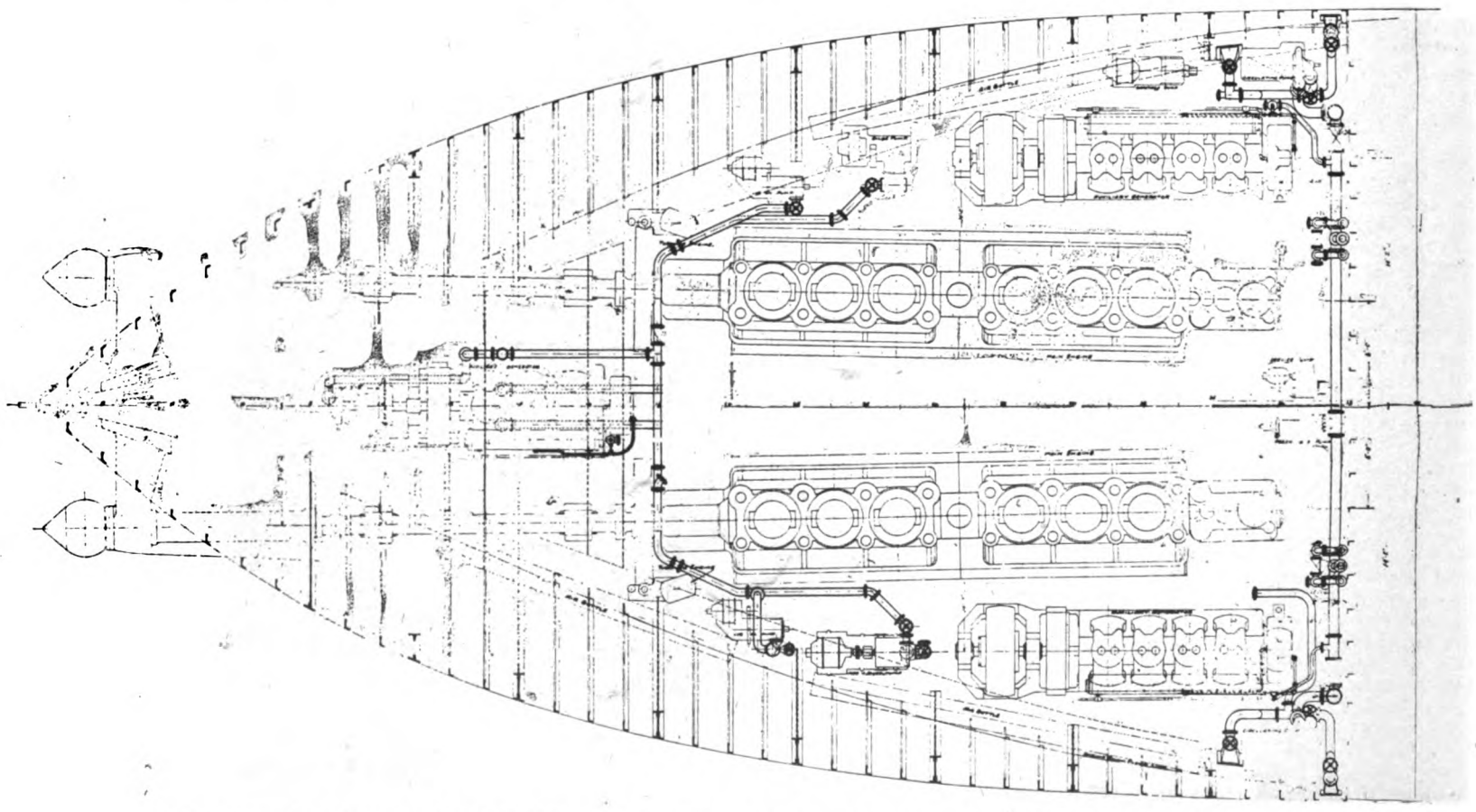
One 2-h.p. General Electric motor drives a Kinney fuel-oil service pump, which is arranged to draw from the engine-room double-bottom and after cofferdam and discharge to the daily fuel service tank.

One motor-driven fresh-water pump is arranged to draw from the after peak tank, fresh-water storage tank on deck, and to discharge to after peak tank fresh-water storage tanks, service tanks on after deck house; also to service tank on upper and navigating bridge.

There is one lubricating-pump, motor-driven, arranged to draw from the lubricating-oil drain-tank, and discharge through the lubricating-oil cooler to the main engines; also through filter to the lubricating oil storage tanks.

One donkey-boiler feed-water pump horizontal duplex, steam driven, is arranged to draw from sea and from the circulating water overboard discharge, and to discharge to the donkey-boiler.

The donkey-boiler will be 6 ft. in diameter and 10 ft. high of the submerged type. Steam outlet is to be connected to the oil-tank steaming-out lines, heating-coils in the fuel-oil, daily-service tank, distiller and donkey-boiler feed-water pumps. The boiler is to be fired by the Ray oil-burning system. Piping will be fitted for installing electric circulating type water-heater.



Engine-room plan of motorship "F. H. Hillman." Considerable space is saved compared with steam-engines and boilers

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The auxiliary compressors are of the Rix type furnished by the Rix Company of San Francisco. The low-pressure compressor will be of the duplex tandem type, two stage, 9 in. x 4 in. x 6 in., with a capacity of 125 cubic-feet of free-air per minute, and provided with intercooler. This compressor is arranged to draw from atmosphere and discharge into the manoeuvring tanks at 350 lbs. pressure, and the booster-compressor is arranged to draw from the manoeuvring tanks at 350 lbs. pressure, and to discharge to the injection-air bottles of the engines at 1,000 lbs. per square inch. The booster compressor is also arranged to draw from atmosphere and to deliver full pressure to injection bottles.

There is one oil-engine direct-connected to a 10 k.w. 250-volt generator, and one balancer set connected between the main bus on the switch-board and the lighting load to obtain a 3-wire 125-volt system for the same, the balancer set being of the General Electric type, 38 amperes and direct connected.

Two Sturtevant blowers will be provided for circulating air, one blower to be located on the main-deck aft for ventilating all living quarters under the poop-deck, the second to be located in the controller-room forward to take suction through 18-inch ventilators and to discharge into common ventilating pipe leading into the pump-room and branching off to the motors on cargo-oil pumps and bilge pumps.

An engineers' workshop and storeroom will be located on the main deck aft and fitted with the following machinery, tools, etc.

One Lodge and Shipley direct motor-driven 16-in. x 10-in. lathe, with taper attachment, and all accessories, including 6-in. Universal chuck, and one large and one small face-plate; one direct motor-driven 22½-in. Barnes drill-press; one direct motor-driven double emery-wheel 12-in. diameter with a 2-in. face; one combination vise and ordinary vise fitted on work-bench with drawers under same.

Two McNab direction-indicators, one for each engine, are to be located on the navigating-bridge. There will be one electric sounding machine of the latest approved type, and a wireless and submarine signal outfit, also two Wagner Cherub patent logs. In place of the usual searchlight installation there will be two flood lights, one at each end of the navigating bridge.

Telephones of the Magnavox design will be installed between the pilot-house and the engine-room, also between the pilot-house and the docking-bridge, and between the docking-bridge and the engine-room, and between the engine-room and the captain's room and from the captain's room to the wireless-room.

The galley is to be fitted with range, broiler, bake-oven, steam-table and water-heater—all electrically operated. All wiring for electrical machinery is to be direct-current with a maximum voltage drop not to exceed 3 per cent. All wiring for motors, heaters, galley equipment is to be 250-volt 2-wire and 125-volt 3-wire for lighting, these two systems to be kept entirely separate. The electrician will have a work-room under the bridge-house. For the cold storage department there will be one 2-ton Audiffen-Singrun ice-machine, water supply for same being taken from the auxiliary circulating line. The insulation and construction of the cold storage system follows the plan of the American Balsa Corporation, utilizing "Encysted Balsa Wood."

On the starboard side of the upper bridge will be located one 18-foot motorboat with 5-h.p. Union gasoline-engine, and on the port side there will be located a 16-foot workboat. Four 20-ft. metallic lifeboats will be located on each side of the after deck house. All lifeboats, the motorboat and workboat will be suspended from davits made by the Steward Davit and Equipment Corporation.

There will be two lubricating-oil coolers and two filters, the filters to be arranged to drain to the lubricating-oil drain tanks and overboard. Lubricating-oil will be carried in a 1,500 gallon storage tank located on the main deck and arranged to drain to the drain-tank built into the engine-room double-bottom, that also takes the drain from the engine crank-pits.

The fuel-oil service-tank has a capacity of 70 barrels and is divided into three compartments. Fifteen barrels of kerosene is carried in a special tank provided for this purpose. The manoeuvring-air tanks, of which there are four, are arranged in the wing space in the engine-room. The main and auxiliary engine silencers are on the housing on top of the after deckhouse, and the exhaust-pipes from the silencers will be carried up along the mizzen mast.

All steam and main and auxiliary exhaust-piping in the engine-room are to be insulated with Magnesia non-conductor material and covered over with canvas.

Fresh water tanks will be located as follows: Two 1,500-gallon storage tanks on the main deck aft; one 1,500-gallon service tank on top of the after deck house and draining into fresh water service in galley and all quarters aft; one 400-gallon service tank on the upper bridge supplying the officer's quarters and hospital amidships; one 200-gallon service tank in navigating bridge supplying captain's quarters.

MAIDEN VOYAGE OF MOTORSHIP "AFRIKA"

Readers of "Motorship" will remember the fine cargo-passenger Diesel-driven motorship "Afrika" recently described and illustrated in these pages—she being the largest Diesel-driven vessel yet completed at the Burmeister & Wain Shipyard, Copenhagen, and having the same power installation as is being installed in the United States Shipping Board's motorship "William Penn," which will shortly run her trials.

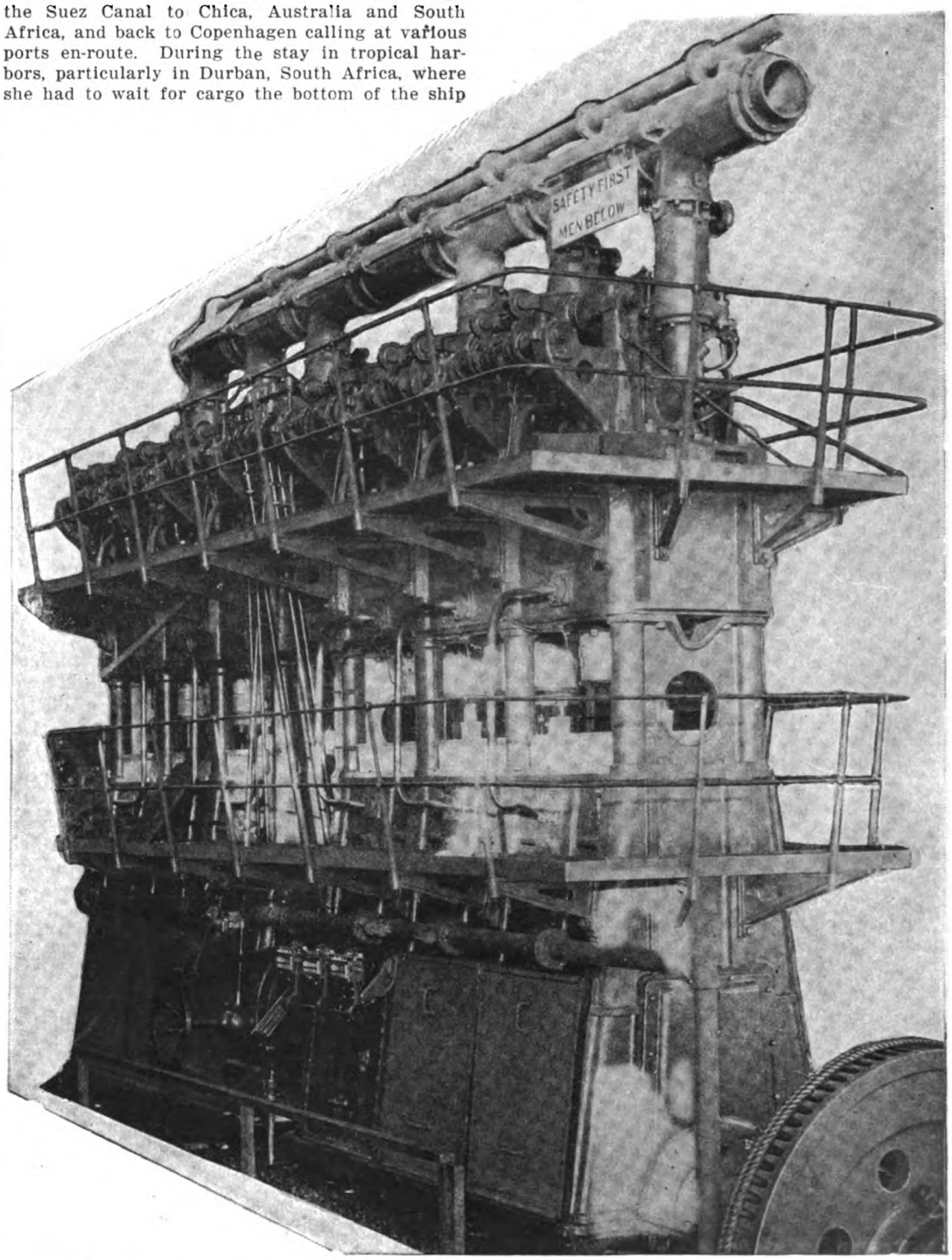
The "Afrika" is of 13,250 tons d.w.c. and has now completed her maiden round-voyage. This voyage was from Copenhagen, Denmark, through the Suez Canal to Chica, Australia and South Africa, and back to Copenhagen calling at various ports en-route. During the stay in tropical harbors, particularly in Durban, South Africa, where she had to wait for cargo the bottom of the ship became covered with barnacles which resulted in slower speed on the return voyage.

The following are some condensed details of the most excellent voyage made—

Distance run	29,523 naut. miles
Time at Sea	2,676 hrs., 15 min.
Average Net-Cargo Carried	11,750 tons
Average speed for entire voyage	11.03 knots
Average Daily fuel-consumption	14.16 tons
Fuel used (Borneo crude-oil)	0.943 gravity
Total consumption of lubricating-oil (all purposes)	46 bbls.
Bunker Capacity	1,470 tons

We will point-out that the thermal value of the fuel used was 990 calories per Kg. or 17,800 B.T.U. per pound. On the outward trip with a full-load on a 25 ft., 6 in. draught a mean speed of 12.05 knots was made between Port Said and Singapore, a distance of 5,062 miles. On one day 313 nautical-miles were logged in 24 hours during fair weather, or an average speed of 13 knots for the day. Generally speaking, very rought weather was experienced, as is shown by the two illustrations which were photographed in the Indian Ocean on August 13th and 15th, 1920. (See page 141.)

On the voyage back to Denmark a fire broke-out in the after hold, spontaneous combustion having occurred in the 4,500 tons of coal she was transporting. Discharging was quickly commenced, and the center of the fire reached before much damage was done to the ship.



End view of one of the Skandia-Werkspoor Diesel-engines of the "F. H. Hillman"

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MOTORSHIP

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CRITICISING AN UNKNOWN QUANTITY

Discussing the four 20,000 tons d. w. motorships ordered by the Bethlehem Steel Company from its own plants the London "Times" (Engineering Supplement) says that—"it is questionable if the Bethlehem-West two-cycle Diesel-engines of these ships will prove as successful as Mr. Schwab anticipates, because there are points in the design that are not regarded favorably by European designers."

Seeing that no official details of the design have yet been published and that apparently no "outsider" has seen the first engine, criticism at this time is perhaps a little premature and even unwarranted. Eventually we shall see, and then there will be plenty of time for comment if called for. Nevertheless, as long as the Bethlehem Co. confine themselves to generalities and remain reticent regarding actual design and definite results, both foreign and domestic criticism unfortunately will surely continue; particularly in the form of an undercurrent—a situation that is regrettable.

We have plenty of confidence in Mr. Arthur West's ability as an engineer, but believe the policy of silence regarding the technical details to be a mistake, and Mr. Chas. Schwab would have greatly strengthened his recent broad claims had they been supported by some actual operating figures that he must possess. Whereas, he has merely laid himself and the engine open to attacks such as those of Sir Trevor Dawson, the "Times" and many others that have been made abroad without proper foundation and which he has left unanswered. A few official facts without any claims would have avoided all this; meanwhile we can only hope that these attacks will not leave an unwarranted stigma on the engine, because the same would be difficult to drive away no matter how successful it is. Unfortunately, past criticisms of the two-cycle system itself made such a deep impression in the minds of shipowners that two-cycle engine-builders have lately had to make tremendous efforts to change opinions. Interests opposed to the progress of the marine oil-engine in America's merchant-marine are already distributing derogatory rumors regarding the "Cubore" and her engines, and base reports have reached us from various sources, including that she ran ashore on Cape Hatteras, and that geared-turbines will be installed in placed the Bethlehem-West Diesel engines ordered for the four 20,000 d.w.c. ore-carriers. We believe that these rumors are spread purposely to block motorship progress, and have no real foundation. In the interests of the industry we hope that the Bethlehem Company will soon release the information.

CUNARD LINE AND MOTORSHIPS

Several recent developments in Great Britain indicate that the Cunard Line is taking active interest in the Diesel-engined motorship—not only for freight carriers, but for moderate-sized passenger liners, especially for one-class and immigrant vessels where speed is limited to the maximum amount of fuel that dare be burned within the limits of economy of operation, and where the low oil-consumption of the Diesel-engine enables a speed of 17 to 18 knots to be maintained with a commercial practicability for this class of ship. From this it is but a comparatively short step to the 20-knot first-class Cunard motor-liner. Incidentally, the radical economic advantages of the Diesel-engine may ultimately mean the segregation of all third-class passengers to special ships.

Readers of the financial pages of the "daily press" probably noticed that the Cunard Line is to issue £4,000,000.00 of debentures for constructing new tonnage during 1921-1922, of which stock one-third will be received by holders of outstanding Cunard debentures and first-mortgage debentures of the Anchor-Brocklebank Line, the latter being an associated concern. Here is the connection that would infer that this new fund of nearly twenty-million dollars will be used for building Diesel-driven ships.

Shortly after the Anchor-Brocklebank Line had ordered several motorships from Cammell-Laird's, the big shipyard of John Brown & Co., Clydebank, acquired a Cammellaird-Fullagar Diesel-engine license with a view to constructing high-powered units, and it will be remembered that many of the largest Cunard liners have been built at Brown's yard. Obviously, then, the Anchor-Brocklebank's entry into the cargo motorship field is largely a conservative try-out of a new system of propulsion that offers promise of success in big units, prior to a heavier investment by the Cunard Line in high-powered motor-liners. As the first vessel—the "Fullagar"—has already proved a success, we presume further delay for the bigger programme has become unnecessary, and that both John Brown and Cammell Laird will receive orders for motorships of noteworthy size, power and speed, as well as orders for some regular cargo motorships. This new construction, it will be noted and digested, comes during a period when orders for uneconomical steamers are being cancelled in large numbers in British yards. Altogether the Cunard Company will build twenty-three craft, aggregating 300,000 tons, of which six will be of 15,000 tons each.

There are shipowners in our country—many new to the business—who have not yet listened to our numerous warnings and who still fondly hope to be able to compete on the High Seas against competition from old established British companies, such as the Cunard Line with its world-wide offices and agencies, and which companies now are balancing their fleets with a total of over one-hundred of the very latest class of economical freight and passenger carriers—namely the oil-engined motorship. It simply can't be done unless American shipowners at least adopt similar types of vessels and similar sound business methods, including wholehearted co-operation with domestic Diesel-engine builders. It is ten years too late to build an "odd motorship or two to give the system a try-out," and the only salvation is to make conversions of existing steamers to Diesel-power on a wholesale scale, and to construct new motorships in batches of not less than six per shipowner, thus securing the lowest possible first-cost. Until Diesel-engines are ordered in reasonably large quantities the constructional costs cannot be much reduced. This must be apparent to any practical shipping-man.

THE DRY-LAW AND MOTOR-LINERS

Possibilities of trans-ocean motor-liners causes one to ponder over the question of the dry-law being enforced on American ships and the probability of its preventing such craft being built in this country in competition with motor-liners now being built abroad. While State laws do not affect foreign-going ships outside of the three-mile limit we do not believe other than that the Constitution of the United States applies to all vessels under the American flag regardless of their whereabouts—the flag itself being symbolic of belief of and adherence to the laws of the land. Nevertheless, in the past there has been a little stretching of the strict legal law in its application on ship-board in international waters, and among other things no ship pays duty on liquor consumed outside the three-mile limit, nor (in actual practice) on the moderate amount used by the officers and crew in port.

Solicitor-General, W. L. Frierson, recently ruled that no alcoholic liquor may be carried or consumed on an American vessel no matter where she may be. In the first place this ruling will be virtually impossible to enforce particularly as far as officers and crews are concerned, except in cases where the captain happens to be a total abstainer of the fanatic type. Secondly, if a strenuous endeavor is made by the authorities to prevent liquor being carried and served to passengers it will simply put American passenger-liners out of the transatlantic service, whether steam or Diesel propelled. Of this we may rest assured! Officers of the vessels will not take upon themselves the work of revenue-agents as few are in sympathy; so, to enforce the law revenue-men will have to be permanently installed on every ship to search passengers' and crew's baggage and to peep into cabins and watch the dining-saloon and smoke-room to see that liquor was not being openly served. In other words act along the lines of spies. Such a procedure would even be obnoxious even to passengers who were the staunchest teetotalers. In a very short time all the passenger traffic would revert to British, Dutch, French and other lines, and our own vessels would be passengerless.

We are not out to advocate liquor consumption or to suggest that the 18th Amendment be not upheld, but are merely coldly indicating what will happen should the Solicitor-General's ruling be enforced aboard passenger vessels. The question is, Does America desire a successful all-round merchant-marine, or would it prefer to see the above amendment legally interpreted in a manner that will drive our passenger-ships off the High Seas? As we are firmly convinced of the great importance of a large mercantile-marine, we consequently feel the necessity of support to the Edmonds Bill, which, if passed, will legally allow of consumption of liquor outside the three-mile limit on American ships.

RUNNING SHORT OF BUNKER-OIL AT SEA

Owing to the comparative low fuel-consumption no Diesel-driven vessel is likely to run short of fuel under conditions recently met with by the Red Star liner "Kroonland," which usually takes about eleven days from Antwerp to New York. On a recent voyage to Belgium she took aboard 3,000 tons of oil, which should have been more than sufficient for a round trip; but owing to high winds and heavy seas her bunker-oil ran out on her return voyage and she was obliged to signal for tugs. When she arrived at Quarantine only 25 tons of oil remained. Normally she burns about 125 tons per day. Were she Diesel-driven she would use between 40 to 43 tons per day, according to the weather conditions. Even in the heaviest weather she would only burn several more tons per day over fine weather consumptions, so climatic conditions should never cause her to run short of fuel-oil. This is another condition which demands economical use of America's dwindling oil supply.

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Air-Injection or Mechanical-Injection

A Technical Treatise of a Subject of Great Importance to Diesel-Engine Builders

By J. L. CHALONER

Part II

(*Continued from page* 1085, *Dec.*, 1920, *issue*)

Considering now the other cycle (Fig. 14) and retaining as far as possible the same lettering:—

(a) Adiabatic ($p v^n$) compression (1-2) giving:

$$\text{Compression ratio } (r) = \frac{VT}{VC}$$

(b) Combustion at constant volume (2-3) giving:

$$\text{Pressure ratio } (P) = \frac{PE}{PC}$$

(c) Combustion at constant pressure (3-4) giving:

$$\text{Cut-off ratio } (R) = \frac{VE}{VC}$$

(d) Adiabatic ($p v^n$) expansion (4-5) giving:

$$\text{Expansion ratio} = \frac{VT}{VE}$$

(e) Exhaust to atmosphere (5-1) giving:

Pressure drop at constant volume = VT

For the thermal changes we get the following relations:

Heat supplied during cycle = HS

$$HS = QS_1 C_p (T_4 - T_3) + QS_2 C_v (T_3 - T_2)$$

$$= QS_1 C_p (R-1) T_3 + QS_2 C_v \left(1 - \frac{P_4}{P_2}\right) T_3$$

Heat abstracted during cycle = HA

$$HA = QA\, C_v (T_5 - T_1) = QA\, C_v T_1 \left(\frac{P_4}{P_2}^{n} R - 1\right)$$

$$\text{But efficiency } (n) = \frac{HS-HA}{HS} = 1 - \frac{HA}{HS}$$

$$= 1 - \frac{QA\, C_v T_1 \left(\frac{P_4}{P_2}^{n} R - 1\right)}{QS_1\, C_p (R-1) T_3 + QS_2 C_v \left(1 - \frac{P_4}{P_2}\right) T_3}$$

But

$$QA = k(QS_1 + QS_2) = KQS;\ C_p \div C_v = n,\ P_4 = P_3$$

$$V_3 = V_2;\ \frac{T_3}{T_1} = \frac{P_4}{P_2}\frac{V_2}{V_1}^{n} = P\, n_r \quad 1$$

$$\therefore\ n = 1 - \frac{K\, P\, (R^n - 1)}{n_r\, (R - P)}$$ equals **Thermal Efficiency**

K is again a constant, depending on the type of engine.

R and P should both have a minimum value in order to give a maximum thermal efficiency.

Examining the two equations for a moment, it will become apparent, that with a combustion at constant pressure, or nearly so, the thermal efficiency is very much higher.

Let us take a Diesel engine and a high-compression engine of the following dimensions:

Air Injection Diesel Engine (Constant Pressure)		
Mechanical Injection High Pressure Engine (Partly Constant Volume)		
Compression ratio (r).....	15.5	13.5
Exponential factor (n).....	1.34	1.34
Cut-off Ratio (R).....	2.5	1.8
Compression Pressure Ratio (P).....	—	1.1

Using the two formulae, given for the Diesel engine (combustion at constant pressure only) and the high-pressure engine (combustion partly at constant volume, partly at constant pressure), it will be found that the thermal efficiencies are as follows:—

Thermal Efficiency:—52.7% 42.5%

This result will explain to a certain extent the discrepancy in the fuel consumption per B.H.P. hour for the two types of engines. Although the mechanical efficiency for the high-pressure engine is some 7% to 10% higher, yet practical results have not shown any corresponding reduction in the fuel consumption.

The principal lesson to be drawn, therefore, from the above results is the necessity of having combustion taking place at constant pressure, and to avoid as far as possible any rise of pressure at the end of compression.

There is no doubt that in those cases of the high-pressure engine, where combustion takes places at constant pressure only, the total combustion period (apart from any after burning which might take place during expansion) is shorter than with the Diesel engine. The reasons for his fact will be discussed later, and in fact is borne out in practice by the cut-off ratio on a high pressure engine indicator diagram being a lower value than for the Diesel engine.

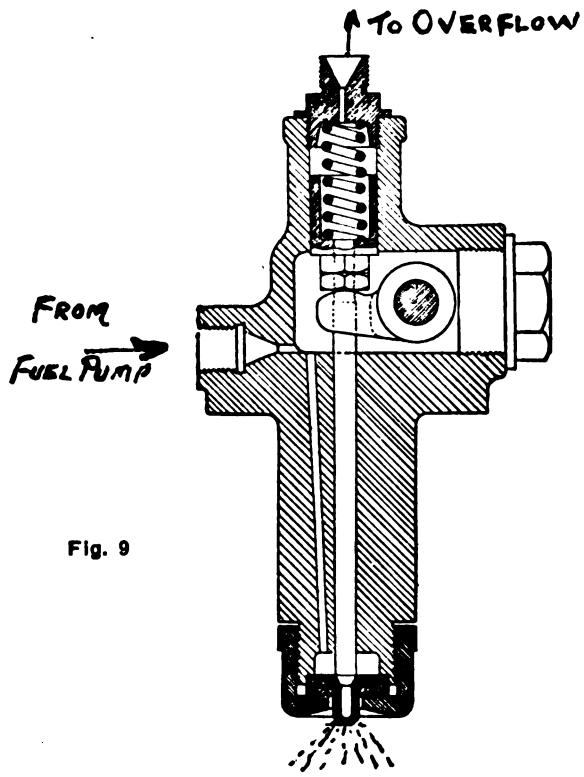

Fig. 9

Comparing the corresponding data in such a case we get the following results:—

Air Injunction (Diesel engine with constant-pressure combustion). Mechanical Injection (High pressure engine with negligible constant-volume, practically constant pressure combustion).		
Compression ratio (r).....	15.5	13.5
Exponential factor (n).....	1.34	1.34
Cut-off ratio (R).....	2.5	1.8
Thermal efficiency	52.7%	54.1%

From these data it will be noted that the cut off ratio has more influence on the thermal efficiency than the compression ratio. Hence the rate of combustion is of primary importance, and the compression is purely governed by the temperature at which spontaneous combustion will take place.

In this connection, the temperature of spontaneous combustion is not the ignition point of the fuel, but is governed by the rate of oil-gas formation, and the ignition temperature of the oil-gas so formed. I am convinced that the ignition temperature of an oil is in no relation to that compression pressure, which will give the best combustion; on the other hand, the War has interfered very greatly with the proposed experiments on the oil-gas formation of fuels, so that even to-day we are not in the position to draw up any definite relations.

The final compression temperature is therefore of no material interest until such times as we are more familiar with the phenomena underying the oil-gas formation. At the same time the following table should be of general interest, and incidentally points out the decreasing rate of temperature rise with corresponding increase of pressures.

Final Compression pressure lbs. p. sq. in.	Final compression pressure temperatures ° F. Initial temperature 80° F.	Initial temperature 122° F.
140	590	645
215	695	770
285	800	875
360	875	960
435	950	1040
505	1005	1100
580	1055	1155
650	1100	1210
720	1145	1255

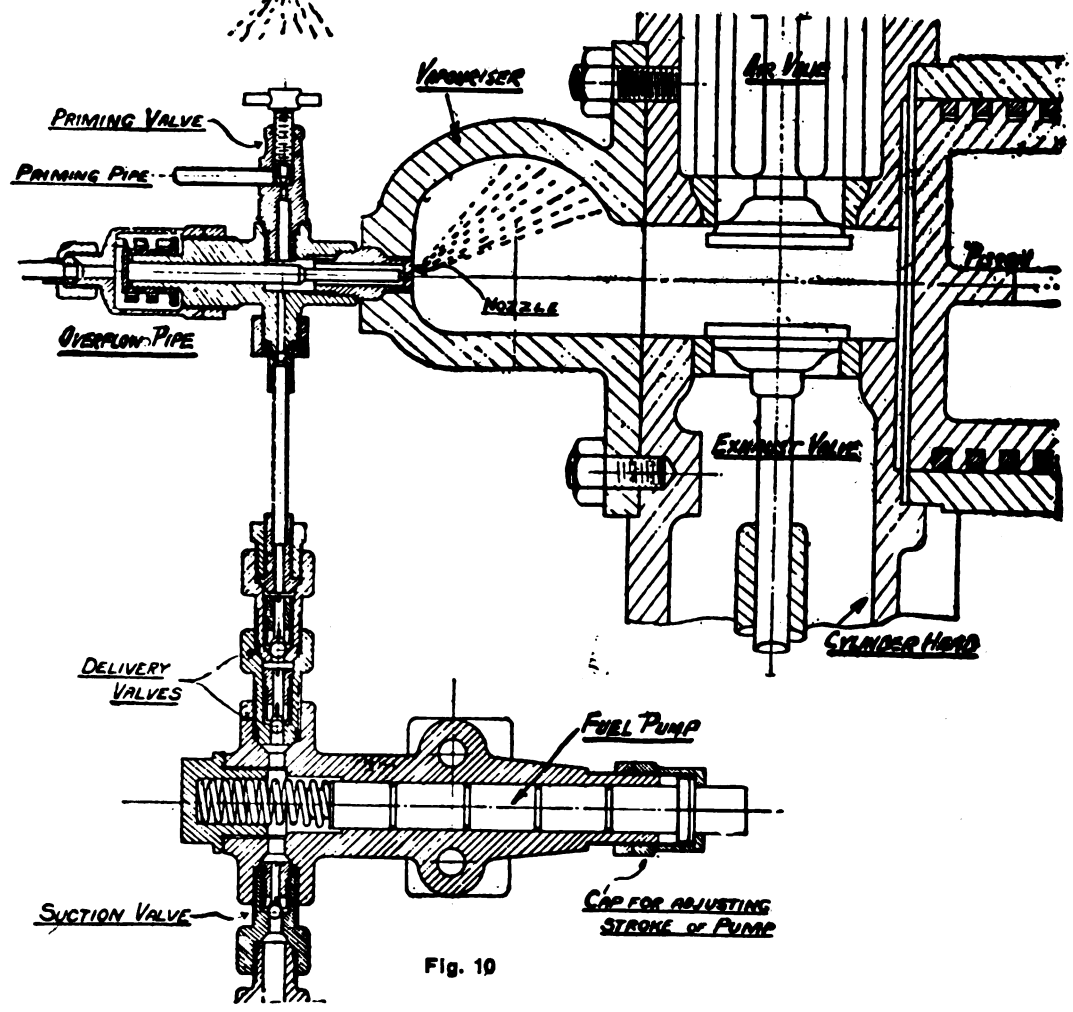

Fig. 10

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If we examine the above table with due regard to the fuels which should be burnt in an engine to justify the term heavy-oil engine, it will be apparent that 285 lbs. compression pressure is about the lowest possible pressure, at which a residual-oil will ignite spontaneously without risking an occasional mis-fire.

If, therefore, the engine were designed to burn at more or less constant volume, the maximum pressure for an engine using a residual oil would be higher than with the Diesel engine. Such policy is not recommended, and it may therefore be stated, that a compression pressure of 350 lbs. p. sq. in. or thereabouts should be employed, and combustion should take places at constant pressure or nearly so.

Such a pressure has never been employed with the Diesel engine, yet it has given every satisfaction with the high pressure engine, using mechanical injection. As has been shown above, the final compression pressure has within limits very little effect on the thermal efficiency, and the relatively low fuel consumption of the engine with mechanical injection despite the lower compression ratio, is entirely due to the more favourable conditions under which the combustion of the fuel is initiated and carried out. This point will be discussed more fully, when dealing with the combustion process proper.

It will be agreed that the thermal relation of the total available heat energy and that portion which is converted into mechanical energy depends primarily on the degree of combustion. In order that the highest degree of combustion should be attained, it is essential that the different stages, through which the fuel is to pass, in order to be physically and chemically suitable for complete combustion, should be arranged for in the correct sequence: It is admitted, of course, that there is no hard and fast rule to be laid down for all of the many fuels which are suitable for heavy oil engines. It is not within the scope of this discussion to refer to the question of suitable fuels for internal-combustion engines in great detail, but from a point of view of general information, the three broad divisions of fuels may be briefly enumerated:

1. Liquid fuels which form chiefly highly inflammable vapours, i. e., vapours passing off on the fuel being heated to temperatures ranging from 65° to 300° F. These fuels are only suitable for engines fitted with carburettors or vapourisers.

2. Liquid fuels, which chiefly change to oil gas, i. e., vapours which are produced on heating hydrocarbons of the aliphatic base, which exist as an open-chain series, between 212° and 750°F.

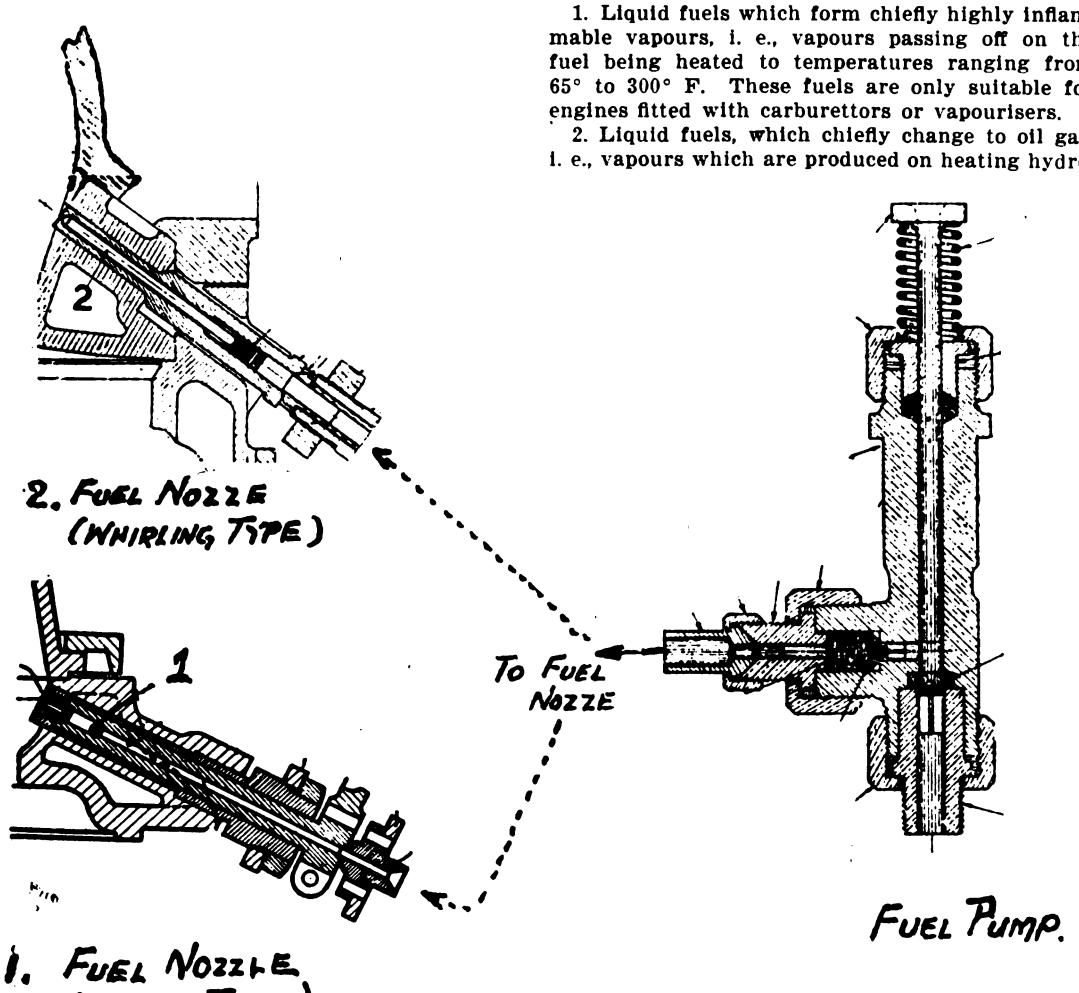


Fig. 11

These fuels are easily dissociated, burn rapidly on account of their high hydrogen contents, are suitable for such engines as are dealt with in this discussion, the suitability depending to a very great extent on the degree of oil-gas formation.

3. Liquid fuels, which on boiling form exclusively oil vapour, i. e., vapour found with aromatic hydro-carbons, which exist as a closed chain or ring structure between 300° and 840°F.

These fuels are only dissociated with additional heat, and owing to their relatively low hydrogen content produce rather sluggish combustion, unless artificially accelerated.

As will be observed, the fuels falling under the second category are found most suitable for Diesel and high-pressure oil-engines, although certain economic conditions of various countries, such as Great Britain and particularly Germany, have compelled the extensive use of such fuels as are enumerated under the third group. These fuels can be obtained from coal, and it is in connection with the attempt to economize as much as ever possible the world's natural fuel supplies, that the suitability of such fuels have been investigated. The results of such investigations will be dealt with in an article which the author has under preparation, and which will appear shortly in the "Motorship."

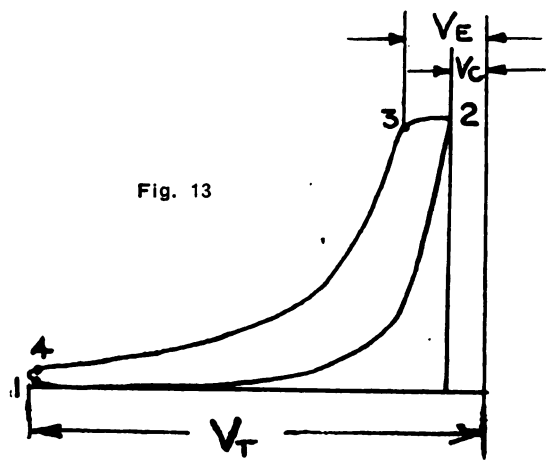


Fig. 13

Reverting now to the main subject, it has been accepted that for the purpose of attaining the highest degree of combustion, it is essential that the following sequence of breaking up the fuel should be adhered to:

1. Atomization of the fuel to the highest possible degree.

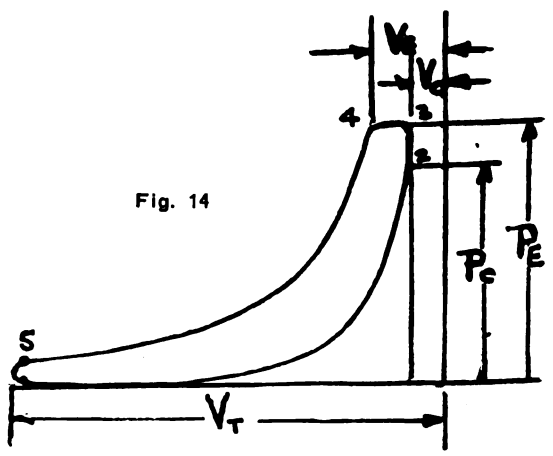
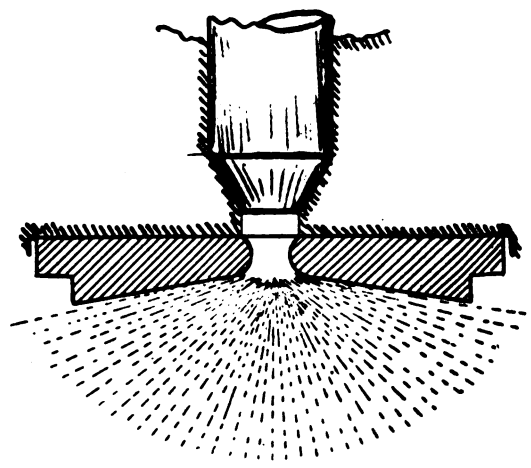


Fig. 14

2. Complete vapourization of the innumerable oil globules, resulting from such a complete atomization.

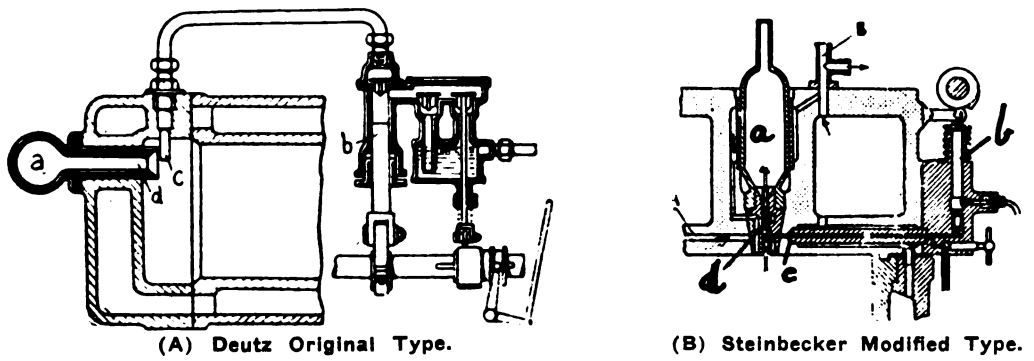
3. Thorough mixing of the oil vapour with the whole of the available air, provided for combustion.

4. Dissociation of this mixture into their respective elements or combustible molecules.



5. Combustion of the elements in the available oxygen of the total combustion air.

1. *Atomization.* It is quite conceivable that the temperature conditions will have a considerable influence of the above sequence to be attained and maintained, and that with unfavorable thermal conditions dissociation may commence at the end or even during the process of vapourization, resulting in the mixing of the oil vapour and the combustion air being only partially completed. Turbulence will, of course, assist in remedying



(A) Deutz Original Type. (B) Steinbecker Modified Type.

Fig. 12

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such a defect, and as a result plays a very important part in the maximum degree of combustion it is possible to obtain under any set of conditions.

It is therefore imperative that in addition to a properly designed fuel atomizing device there is ample provision for an automatic temperature adjustment.

The trend of design is generally indicative of the defects of the general principles underlying that particular design. This argument applies remarkably closely to the fuel atomizing devices suggested with heavy-oil engine construction.

With the original ring pulveriser design, it was anticipated that the flame plate orifice would assist in the formation of a wide-angled conical spray (Fig. 15), whereas the actual result was more like a very narrow jet (Fig. 16). The main flame plate orifice was in consequence split up into a series of narrow channels (Fig. 17), to distribute the oil spray in an appropriate manner over the combustion space. Experiments were carried out to study the effect of small alterations in the size, direction and number of such channels and the following table gives rather interesting results. Although the experiments were carried out with an engine, working on the air-injection principle, the general deductions apply both to the air and mechanical injection methods.

Angle of spray	23°	23°	23°	23°	23°	23°
Number of spray holes	5	6	8	5	6	8
Bore of spray holes	0.0273"	0.0234"	0.0195"	0.0273"	0.0234"	0.0195"
Revolutions per minute	274.8	274.5	276.3	271.3	267.9	267.9
M. E. P. lbs., per square inch	91.8	94.4	94.1	91.7	91.1	94.2
BHP	12.0	12.1	12.1	11.9	11.7	11.7
IHP	17.0	17.4	17.5	16.7	16.4	17.0
Mechanical Efficiency	70.9%	69.4%	69.2%	71.0%	71.5%	69.1%
Fuel per BHP hour lbs.	0.53	0.56	0.56	0.56	0.60	0.66
Net Thermal efficiency	25.2%	24.4%	24.3%	24.3%	22.6%	20.5%
Injection air pressure lbs. per square inch.	740	740	740	740	740	865
Air excess co-efficient	1.78	1.71	1.72	1.71	1.54	1.37
Water circulating inlet Temp. °F	58	58	57	58	58	58
Circulating water outlet Temp. °F	184	184	177	182	181	165
Suction air Temp. °F	70	70	70	72	75	77
Exhaust Temp. °F	653	662	670	655	728	788

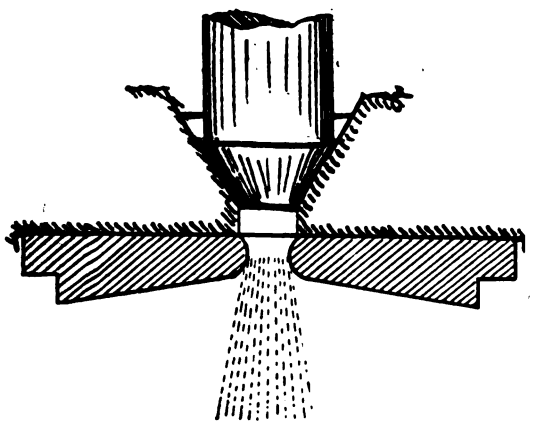

Fig. 16

It should be noted that with the last set of readings, when using an eight-holed flame-plate, having a spray angle of 43°, it was necessary to raise the air-injection pressure from 740 lbs. to 865 lbs. p. sq. in., in order to keep the engine running, although even with this pressure the exhaust was by no means clear. (See Zwerger: The heat diagram as a base for testing an oil-engine.)

By designing a flame-plate with a number of small holes instead of one orifice of reasonable proportions, there is undoubtedly a great tendency of chocking up the narrow channels, especially when employing a residual fuel. Yet on the other hand, in order to produce a definite nozzle velocity, which will stand in favorable relation to the velocity of flame propagation, once the oil-air mixture is ignited, the total cross-sectional area of the flame-plate opening must not exceed a certain value. By using air-injection, a large volume of compressed-air in addition to the fuel charge passes the narrow channels, and the total volume is sufficient to produce a definite orifice velocity without reducing the holes to impractical proportions. Taking, however, the mechanical-injection method, where a charge of oil without any additional air, compressed or otherwise, is forced through the series of pin holes, their bore must be very much smaller in order to retain the required nozzle velocity.

Considering for a moment a practical illustration, we note that in the Vickers 100 B.H.P. per cylinder unit the sprayer nozzle has five holes, each of 0.018 in. bore, which represents a total cross-sectional area of 0.0013 sq. in., or 0.000013 sq. in p. B.H.P.

In the last set of tests, which deals with air-injection method, the best results were obtained with a flame-plate having five holes each of 0.0273 in. bore. The corresponding total cross-sectional area is 0.0029 sq. in., or 0.00024 sq. in. p. B.H.P. The cross-sectional ratio for air and pressure systems is therefore 18.5 to 1. This figure is somewhat low and experimental results have shown, that a ratio of 20:1 is an average value.

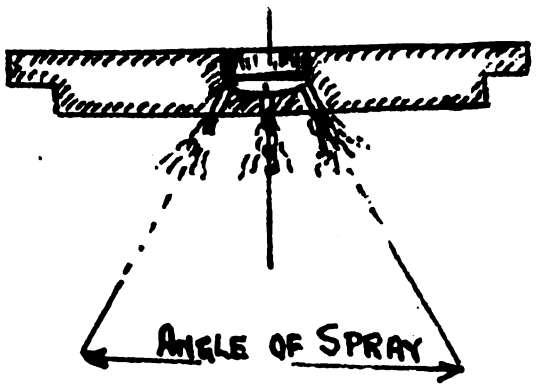

Fig. 17

Considering now for comparative purposes the relative increase in volume of compressed air—the compressed air expands during the injection period from, say, 1000 lbs. p. sq. in. to 485 lbs. p. sq. in.—and oil—the oil on being heated vapourizes and as a vapour or gas occupies a very much larger volume—it will be found that with similar final conditions with regard to temperature and pressure the volumetric ratio is about 1:25. As with the mechanical injection the nozzle temperature will be relatively higher owing to the absence of the cooling effect of the compressed air on expanding, the volumetric increase of the fuel charge on its way through the flame-plate channels will be proportionately higher with mechanical injection than with air injection. As a sequence the nozzle velocity of the oil vapour will in practice not be as unfavorable as might appear on the face of it, and it can be readily seen that by providing correct thermal conditions around the flame-plate orifice, it will be possible to increase the size of the holes accordingly.

In this connection the mechanical injection has a decided advantage, inasmuch as any formation of oil gas or vapours will not endanger the safe running of the plant. With the air-injection method the formation of a gas may, and in fact has, resulted in the formation of an explosive mixture in the fuel-valve casing with rather disastrous effects.

Reverting to the somewhat delicate proportions of the flame-plate holes, we find an analogous case in the case of oil-burners. In comparing the steam-jet and pressure principles, it is recognized, that the pressure system is the better of the two. Yet in practice it has been found that from an all-round point of view the steam jet system is preferred for such size of installations, where the rate of oil passed through each burner does not exceed approximately 150 lbs. per hour. It is again a question of dimensions of the spray-holes, which are larger when employing steam as the medium.

2. *Vapourisation.*

The fundamental condition underlying complete combustion is the vapourisation of the fuel charge prior to mixing the air, which is required for combustion with the fuel.

The distillation curve for a fuel suitable for a marine oil engine shows that evaporation proper—we are here not concerned with possible evaporation due to exposure to atmosphere—begins about 350° F., and is completed about 750° F. To show a comparison between the various grades of fuel, the following table is quoted, and in Fig. 20 the temperature range is shown graphically. The vapourisation curves are in some relation to the I.B.P., although their exact characteristics are not yet fully known.

It should be noted that all the above fuels are used in internal combustion engines of one kind and another, and the initial vapourisation temperatures are to a certain extent a measure of the atomizing agent, thus enabling large sized hole to be used and reducing the risk of choking the holes with carbonized fuel.

It should be remembered, however, that even with the smallest of surface-ignition engines the mechanical-injection principle is retained, and proves quite satisfactory both from a point of running and fuel economy. The grade of fuel used for this class of engine, is very much better than the heavy residuum fuels employed for oil-firing and heavy-oil engine purposes, so that the question of choked nozzles is not purely a question of nozzle dimensions, but also dependent on the grade of fuel.

It is desirable here to compare for a moment the difference between a spray jet and an atomized jet. It is a more or less general impression, that with mechanical injection the oil must be sprayed into the cylinder in a kind of solid stream. However, with certain favourable thermal conditions, it is quite possible to produce a mixture of solid and gaseous particles, and by providing adequate mechanical contrivances, a similar effect can be obtained with an oil/oil vapour mixture than with an oil/compressed air mixture.

Again it has been shown that the degree of atomization possible with compressed air is limited to a minimum size of globule of 0.015 in. to 0.020 in. diameter, and it appears, therefore, evident that for a finer atomization mechanical means must be employed to assist the compressed aid in breaking up the fuel. Such degree of atomization appears rather coarse especially when dealing with heavy residual fuels, and in recent pulverizer designs, the oil channels have been arranged in such a fashion, as to produce a maximum number of changes in the direction of flow, and furthermore "sharp edges" have been introduced, on which the fuel so to speak may tear itself to atoms. Or again the flow of the fuel through the pulverizer has been arranged to create certain differences of pressure, so as to throw the globules of oil with greater force against any intercepting obstacle. Fig. 18 indicates an illustration of the former, Fig. 19 gives the constructional details of the latter suggestion. The designer has obviously realized the limitations of compressed air as an atomizing agent, and has resorted to a mechanical appliance as an additional means of pulverisation.

GRADE OF FUEL	BOILING POINT Initial	TEMPERATURES Final
Gasoline (Motor Spirit)	70° F.	375° F.
Kerosene	250° F.	575° F.
Gas oil	325° F.	700° F.
Light Fuel Oil (26 Baume)	350° F.	750° F.
Heavy Fuel Oil (17 Baume)	375° F.	800° F.

A further point of considerable importance is the variable load condition. It is known that with the ordinary type of pulverizer the injection air pressure must be adjusted in relation to the load. Too high an injection pressure will produce bumping and give a whitish colour of exhaust, whilst too low an injection pressure will be accompanied by a falling-off of the power and a smoky exhaust.

If the injection pressure is to remain constant irrespective of the load, then refinements have to be introduced in the design, which have been considered as delicate and impracticable when evolved in conjunction with mechanical injection.—[Figs. 18 and 19 will be given in our next issue.]

(To be continued)

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New American Solid-Injection Engine

Small Marine Diesel-Motor with Mechanical-Injection of Fuel, Built on the Pacific Coast

(Contributed)

FOR many years the only Diesel-engine builder using the solid-injection of fuel system with high cylinder-pressure in a commercial way was Vickers, Ltd. of England, who have developed it and adopted it for all their submarine engines. much outside interest was evinced and many experiments were carried-out by other engineering concerns here and in Europe; but none equipped their engines with it as a standard for marine work. Even the results then being obtained abroad were kept strictly secret by Vickers and the British Navy. After the war, as is now known, the veil lifted and the results were made public, and much interesting information was given in the issue of "Motorship" of November, 1919, when it was revealed that on Admiralty tests consumptions as low as 0.37 lb. per brake horse-power were secured with a number of engines on different occasions when running on good grades of fuel. Also that all the British submarines, some monitors and tankers were equipped with solid- injection Diesel-engines with excellent results. Then the Anglo-American Oil Co.'s 10,500 tons d.w.c. tanker "Narrangansett" arrived here and added further impetus to the movement already in progress among some American concerns.

Mechanical-injection is perhaps a better term than is "solid-injection" and probably will be the ultimate name to be employed in this country, as it more clearly denotes the system, or rather the working of the same.

A marine oil-engine of the mechanical-injection type has recently been completed by the Enterprise Engine Company of San Francisco and we understand has been constructed under license and patent rights; altho under what license information is not available. It is a three-cylinder marine-engine of the four-cycle trunk-piston type rated at 75 b.h.p. but actually developes 90 b.h.p. at 325 r.p.m. It is not intended to produce this engine in large sizes at present, but they will be built up to 200 b.h.p.

The first engine is not reversible; but is equipped with a mechanical reversing-mechanism and clutch, which is controlled by a large hand-wheel. Figure 1 depicts the engine on the test-bed coupled to a brake, the splash-plates and cam-shaft-cover being removed to show the arrangement of cams and valve-timing; also the helical-gear for the camshaft drive. It will be noted that the valve-rockers are actuated by long push-rods.

Reference to Figure 5 will show the fuel-pump and governor control. To the right of the fuel-pump is a set of three cams for one cylinder—the cam at the extreme right being the exhaust-cam. The relief-handle (A) is used to relieve the compression while the center cam actuates the air-starting valves and is arranged to automatically cease to operate when the starting air is shut-off and fuel admitted. The cam on the left side is the air-inlet cam operating the inlet valve. Alongside the governor is the main control-lever for operating the engine. Reference to the upper part of this illustration will show a special feature of the cylinder-cooling. There is an outside connection (BB) through which water is passed from the cylinder to the cylinder-head with a view to eliminating gasket trouble at the joint. These water connections are arranged on the forward and after sections of the cylinder enabling good circulation around the valves.

A view of the forward part of the engine is shown in Figure 4 and it will be noted that the cam-shaft and gear is enclosed, while over the casing is a single-cylinder air-compressor (C) driven direct from the crank-shafts. Between the crank-case and the fly-wheel is a plunger-type water-cooling pump.

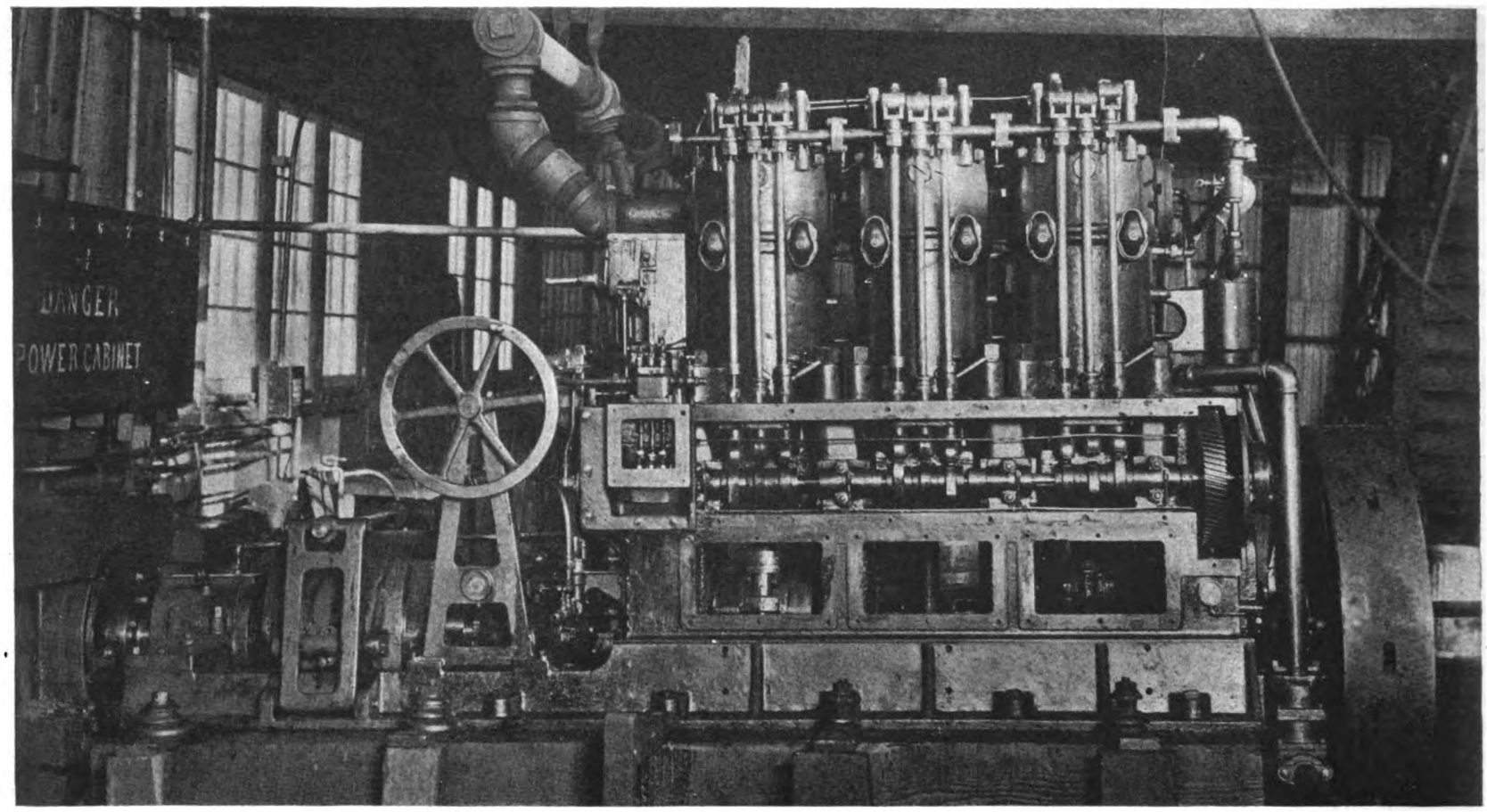

Fig. 1.—General view of the three-cylinder Enterprise solid-injection Diesel marine-engine

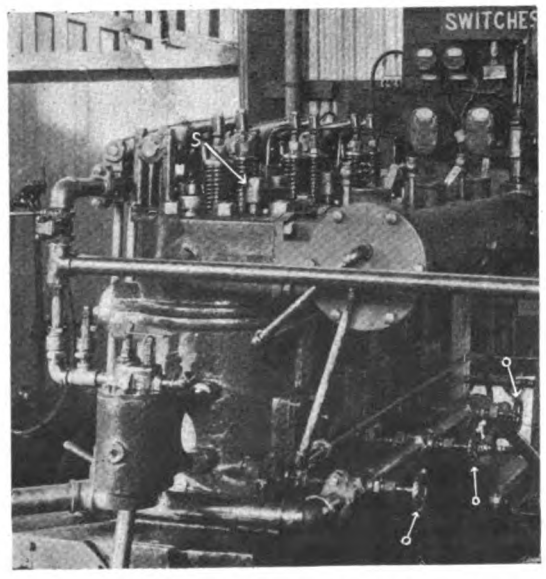

Fig. 2.—Forward view of Enterprise Diesel-engine showing valve operating-mechanism and air-pump

As air is only used for maneouvring and for the vessels siren, no air being required for the injection of fuel—only a small single-stage air-pump is necessary instead of the usual three-stage compressor. Lubrication is under pressure and the method of lubricating cam-shaft bearings can be seen at "D.D." and lubricating-oil is furnished by an oil-pump located at the after part of the engine, while the gauge (E) indicates the oil pressure, which is designed to be maintained at approximately ten pounds per square inch.

By referring to Figure 5 a fuel-pump can be seen. It is driven off an eccentric at the after end of the cam-shaft. A Manzel force-feed lubricator is also operated from the same eccentric and carries oil-feeds to different working parts of the engine, including to two points on each cylinder. The fuel-pump referred to draws the fuel from the main-tank to the auxiliary-tank at "H" near the rear cylinder. This tank has two compartments, one for fuel-oil of 14 degrees gravity and the other compartment for 20 degrees gravity fuel-oil used for the purpose of starting—the 14 degree oil being so heavy that the pumps cannot handle it until the engine is warmed-up.

The forward end of the engine is shown in Figure 2, and this gives a comprehensive idea of its general design to construction, also the valve arrangement in the cylinder-heads. It will be noted that the cylinders are cast separately and are mounted on a cast-iron box frame which in turn is bolted to the bed-plate. At "S" special brackets are arranged under the exhaust-pipe to carry it when the cylinder-heads are removed for inspection, which enables the heads to be lifted-off without dissembling the exhaust-header.

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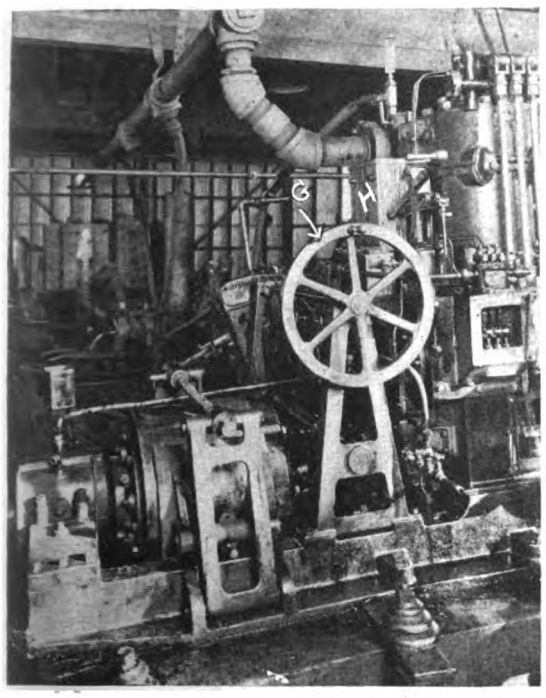

Fig. 3.—Reversing Mechanism of Enterprise engine

In the fore-ground there are two half-inch pipes leading to the flange of the exhaust-header. These are used for the purpose of heating the 14 degree gravity fuel-oil in order that it may flow readily through the pumps and pipes. The single-stage air-compressor can also be seen between the fly-wheel and the forward cylinder. A special gate-valve is connected to the air-line from the air-pump to the starting-air manifold on the cylinder-heads and only comes into operation when starting the engine.

With further regard to lubrication, oil is run through the lower part of the engine bed-plate through a ¾ inch pipe that has two separate leads to each main-bearing for the purpose of lubricating the crank-shaft, and a continuous flow of oil is maintained under pressure on the engine-shaft. It will be understood that when the holes in the main journal of the shaft come in line with the bearing oil-holds, the oil is forced through pressure into the holes in the crank-shaft, lubricating the crank-pin bearings in addition to the main journals. In a similar manner the connecting-rod is drilled with an oil-hole to the wrist-pin so that when the crank is at the top center the oil flows up from the crank-shaft and is forced through the connecting-rod into the wrist pin bearings.

Inside the box-type engine-frame there is a detachable cast-iron skirt to each of the cylinders which can be disconnected from the latter by removing nuts on four studs. With the crank at bottom center the piston can then be removed through the crank-case doors. It will be remembered that the detachable skirt for cylinders was first producted by the Werkspoor Company under patents, and later on was adopted by the Busch-Sulzer Company and by the Midwest Engine Company on small high-speed Diesel engines. Regarding the fuel-pump, this is actuated by cams keyed to the cam-shaft and automatic changing of the stroke of the fuel-pump with a view to regulating the amount of fuel injected at different loads which is carried-out by a centrifugal-governor driven off the cam-shaft.

As we have previously mentioned, a mechanical reverse-gear is fitted and this is of the plain spur-gear type with forged steel pinions and gears, the pinions being bushed with plaxtic bronze and are housed in an oil-tight case, so run in a bath of lubricating compound. The clutch is of the multiple-disc type and inspection of the same is easily accomplished by removing bolts holding the reverse-gear extension-piece. The main engine crank-shaft is a one-piece forging, machined to 5½ inch diameter. Unfortunately, no details are available regarding the technical datae of the injection-nozzle used, or of the mechanical-injection pump; but we understand that the pressure of the fuel-pump is compartively low. We also understand that particular care was also made in connection with the casting work of the cylinder and cylinder-heads, etc. and that the castings were made in the Enterprise Company's own foundry, following careful experiments with mixtures and chemical analysis. The Enterprise Company has been constructing parts for the majority of distillate engine-builders in the San Francisco district for about thirty years, so have had considerable experience in the small marine-engine field.

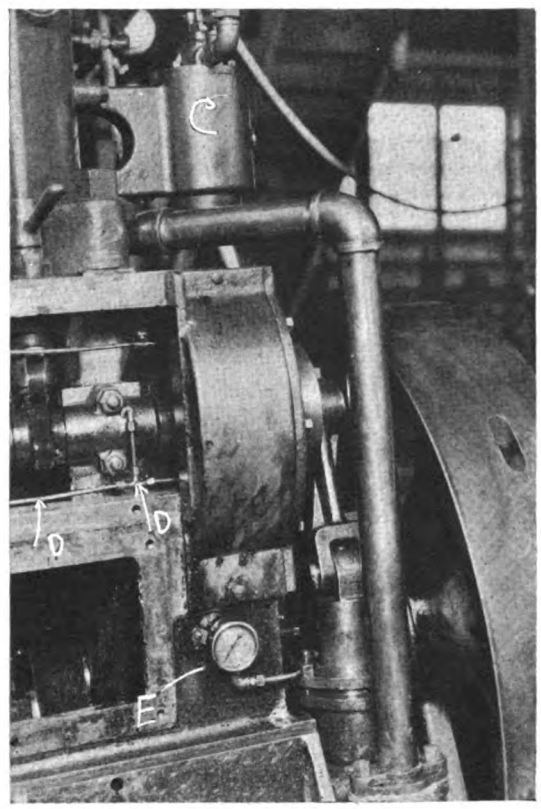

Fig. 4.—View showing lubricating arrangement of camshaft bearings

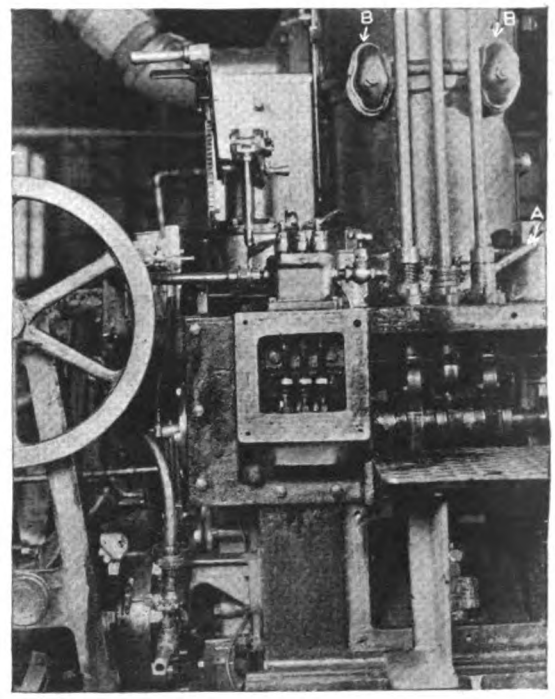

Fig. 5.—View showing fuel-pump and governor arrangement of the Enterprise engine

Ships Built on Isherwood System

The annual report on the progress of the Isherwood system of ship construction for 1920, reflects in a very interesting way the position of the world's shipbuilding generally, for the year just come to a close. From the date of its commencement, which period includes the twelve months ending December, 1908, to the close of 1920, less cancellations during the latter period, the appended list shows the gradual and remarkable progress of the Isherwood system in the number of ships constructed on the Isherwood plan, with a corresponding total of deadweight tonnages.

While the table presented is confined solely to Isherwood ships, it is nevertheless, something in the nature of an authentic record of the fluctuating phases in shipbuilding generally throughout the world.

	Number of ships	D. W. Tonnages
Sept. 1907 to Dec. 1908	6	31,608
1909	36	212,992
1910	76	484,752
1911	140	958,795
1912	240	1,777,348
1913	270	1,993,034
1914	311	2,351,322
1915	468	3,548,221
1916	620	4,666,000
1917	800	6,332,150
1918	1,050	8,707,700
1919	1,260	10,594,700
1920	1,395	11,962,400

It will be seen from the above table, that the Isherwood System progressed steadily from 1907 to 1911 and that for the year 1912, when oil tankers were in great demand, the number of ships constructed on the Isherwood plan during that year numbered 100.

During the first two years of the war the returns show a large increase, the number of ships on the ways during that year being 157 and 152 respectively. During the years 1917-1918, when the boom in shipbuilding began, the United States having joined with the Allies in an endeavor to expedite the output of tonnage, the number of ships again largely increased, 180 and 250 vessels being constructed—on the Isherwood system—during those two respective years.

With the conclusion of the World War and the consequent process of stocktaking resulting in a number of cancellations of emergency orders, the returns naturally show a falling off and, consequently, for 1920, the figures show a considerable drop in the number of new ships built, from those during the immediately preceding war years.

The figures for 1920 include oil-tankers aggregating more than 1,000,000 tons deadweight carrying capacity, which is an interesting commentary on the prophecy made by our shipbuilding authorities and experts that, during 1920, there would be a world's deficit of about a million tons of oil carrying tonnage as against the demands for oil fuel supplies. As a matter of general interest it may be mentioned that most of the tankers included in the 1920 figures range from 8,000 tons to 20,000 tons deadweight and that two vessels are of 20,000 tons deadweight designed for the carrying of ore and oil and will be Diesel driven.

BRITISH AND DUTCH REDUCE BUNKER-OIL PRICES

Partly Due to Transportation Economies Effected by Use of Diesel-Motor Tankers

EARLY last month important price reductions of bunker-oil were made by the Asiatic Petroleum Co. of London, which is one of the subsidiaries of the Royal Dutch-Shell combine. The prices per ton are as follows:

Adelaide	$47.00	Melbourne	$47.00
Alexandria	46.00	Mombassa	46.00
Amsterdam	30.75	Nagasaki	43.25
Avonmouth	220s	Palambang	43.25
Balik Papan	$27.00	Panama Canal	24.50
Bangkok	43.25	Pangkalan Brandan	43.25
Batavia	43.25	Penang	43.25
Bombay	43.25	Port Said	46.00
Calcutta	43.25	Pulo Samboe	43.25
Cape Town	46.00	Rotterdam	39.75
Colombo	45.25	Saitozaki	43.25
Glasgow	220s	Santos	48.25
Hong Kong	$43.25	Shanghai	43.25
Hull	220s	Singapore	43.25
Hurghada	$46.00	Soerbaya	43.25
Karachi	43.25	Suez	46.00
Las Palmas	39.75	Sydney	46.00
Lisbon	39.75	Tarakan	27.00
Liverpool	220s	Trinidad	20.00
Madras	$43.25	Yokohoma	43.25
Malta	46.00		

About 25 of the Asiatic Petroleum Company's tankers are Diesel-driven, and a few are propelled by surface-ignition oil-engines, which types of machinery allows of the lowest transportation-costs of oil supplied to the bunker-stations.

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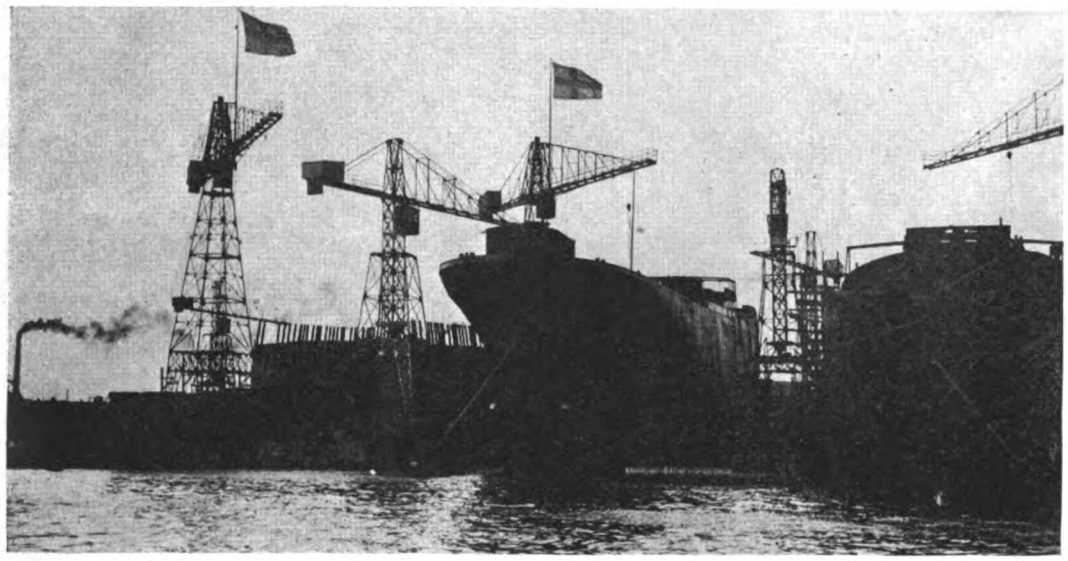
Interesting Notes and News from Everywhere

FAIRFIELD TO BUILD DOXFORD ENGINE

The Doxford opposed-piston type marine Diesel-engine is to be constructed under license for merchant-ships by the Fairfield Shipbuilding & Engineering Co., Govan, Glasgow.

STEAMERS AND MOTORSHIPS IN GREAT BRITAIN

More steamship orders have just been cancelled in Great Britain, including four cargo-passenger vessels of 10,000 tons each belonging to the Lloyd Royal Belge. But the numerous orders for Diesel-motorships still hold good.



The motorship "Canada" ready for launching at the Götaverken yard. Three more Diesel motorships are on the berths

MOTORSHIP "GLENIEG" LAUNCHED

The large Diesel motorship "Glenieg" of the Glen Line was launched by Harland & Wolff towards the end of December.

LAUNCH OF BIG MOTORSHIP "GLENBEG" ON XMAS DAY

To the order of the Glen Line of London, the new 14,000 tons d.w.c. 9,500 tons gross Diesel motorship "Glenbeg" was launched on Xmas Day at Harland & Wolff's Govan shipyard. Twin 3,300 i.h.p. Burmeister & Wain type Diesel engines are installed.

COPY OF "MOTORSHIP" AUGUST, 1919 REQUIRED

We have been advised by the Augsburg Works of the Maschinenfabrik Augsburg-Nurnberg, A. G., Augsburg, Germany, that they particularly desire copy of "Motorship" for August, 1919. Unfortunately we are entirely sold-out of copies of this issue, and we will be glad if any reader who has a spare copy will send same to the above concern.

SMALL MAIL AND PASSENGER MOTORSHIP

To the order of the Saltens Steamship Co., Bodø-, Norway, a small passenger motorship has been launched by the E. Nofdbjaerg's Shipbuilding Co., Faaborg. She is 80 ft. long b.p. and is propelled by a 124 b.h.p. heavy-oil engine at 9 knots. She will be used for mail and passenger service along the north Norwegian coast. She is classed to the Norwegian Veritas.

ATLANTERHAVET COMPANY CHANGE STEAMSHIP ORDER TO DIESEL POWER

Some time ago there were ordered at the new Southern yard of the Copenhagen Floating Dry Dock, three 7,000 tons geared-turbine freighters to the order of the Atlanterhavet Shipping Company of Copenhagen. Two of these steamers have been delivered; but the owners have decided to instal Diesel-engines in the third vessel, and the propelling machinery will be supplied by Burmeister & Wain of Copenhagen.

TWO MOTORSHIPS BUILDING AT KOCKUM SHIPYARD

Government subsidies have been granted to the owners in connection with the two 6,550 tons d.w.c. motorships now building at the Kockum Shipyard, Malmo, Sweden, which vessels are similar in size to the motorships "Lima" and "Valparaiso" of the Johnson Line, but will have slightly lower power. These two motorships are being built to the order of the Swedish America-Mexico Line, and the Swedish Farmers Shipping Company, Ltd., and have been previously referred to in the columns of "Motorship." Only the hulls will be constructed at the Kockum Yard and after launching they will be towed to Burmeister & Wain's yard at Denmark where twin-screw Diesel-engines aggregating 2,100 i.h.p. at 150 r.p.m. will be installed.

ERIKSBERG CO. BUILDING MOTORSHIP FOR SWEDISH LLOYD

A single-screw motorship of 1,800 i.h.p. and 4,000 tons d.w. is now under construction for the Swedish Lloyd at the yard of the Eriksberg M.E.V., Göteborg, Sweden. The engine for this vessel is being built by Götaverken, and is of the Burmeister & Wain type.

WALLSEND SLIPWAY TO BUILD DIESEL ENGINES

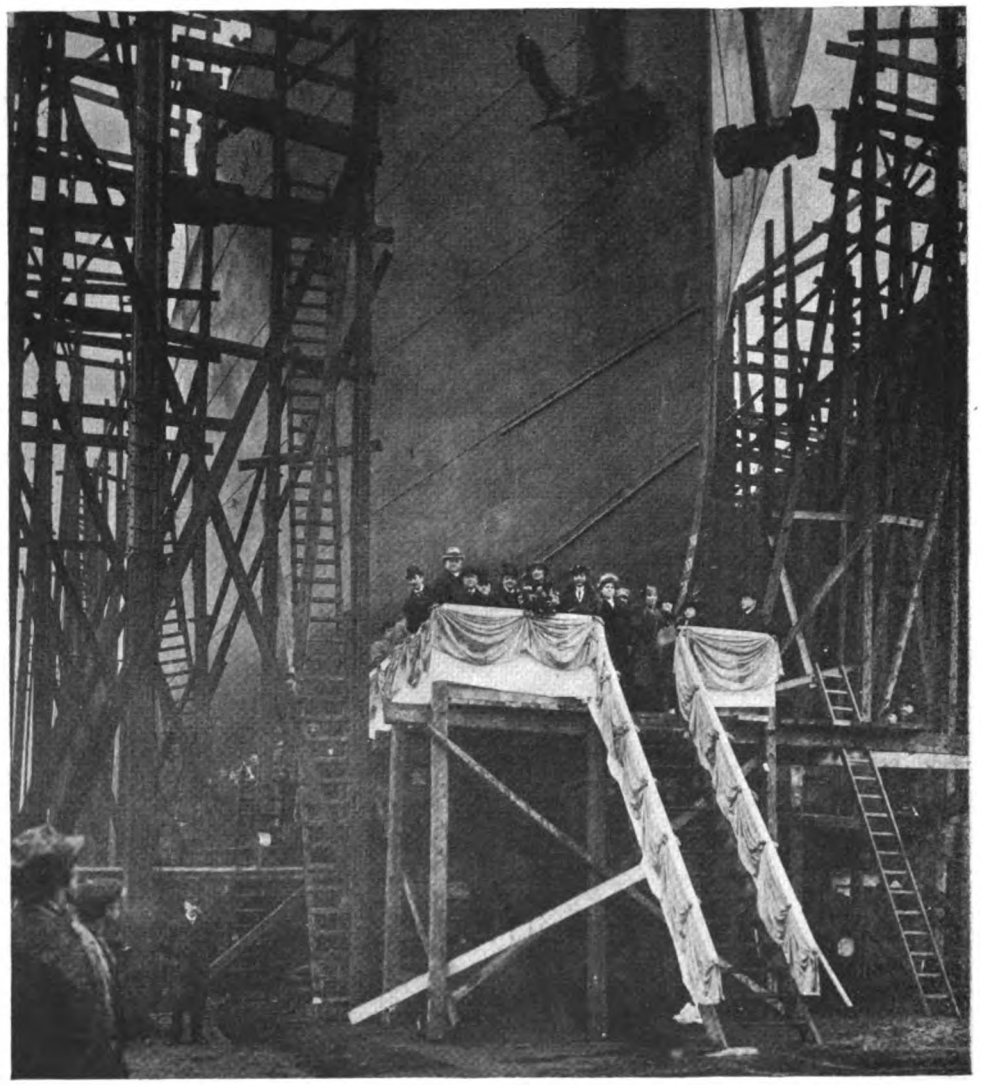
Rapidly growing in number are the list of British shipbuilders who have actively taken-up the construction of marine Diesel engines and motorships. The latest on the list is the Wallsend Slipway & Engineering Co. of Wallsend-on-Tyne, England, who have recently acquired a Sulzer two-cycle Diesel license.

NEW MOTOR FERRY-VESSEL

According to a report received from Cleveland, the Anchor Shipbuilding Co., Washburn, Wisconsin, has under construction a motor-driven steel ferry-boat building to the order of the Hudson and Athens Ferry Co., Hudson, N. Y. The hull dimensions are 115 feet overall, 33 feet molded beam, 44 feet over guards, depth 12 feet, and draft 7 feet. This vessel will have two propellers—one at each end.

MOTALA VERKSTED TO BUILD DOXFORD-ENGINED MOTORSHIPS

Information has reached us that the Motala Verksted of Motala, Sweden, has secured a license from Wm. Doxford & Sons, Sunderland, England, to build their opposed-piston type marine oil-engine, and that they have received an order from the Transatlantic Steamship Co. of Gothenburg for two single-screw 4,000 i.h.p. motorships of about 8,000 tons d.w.c. The shipyard connected to this company is known as the A/B Lindholmen-Motala, Göteborg.



Launch of motorship "Canada" at the Götaverken. The gentleman in the soft gray hat is Mr. Dan Bröstrom, the Swedish shipping magnate, who has decided to build a 600-ft. 16,000 i.h.p. transatlantic motor-liner to be operated by the Swedish-American Line

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MARINE PROPELLERS

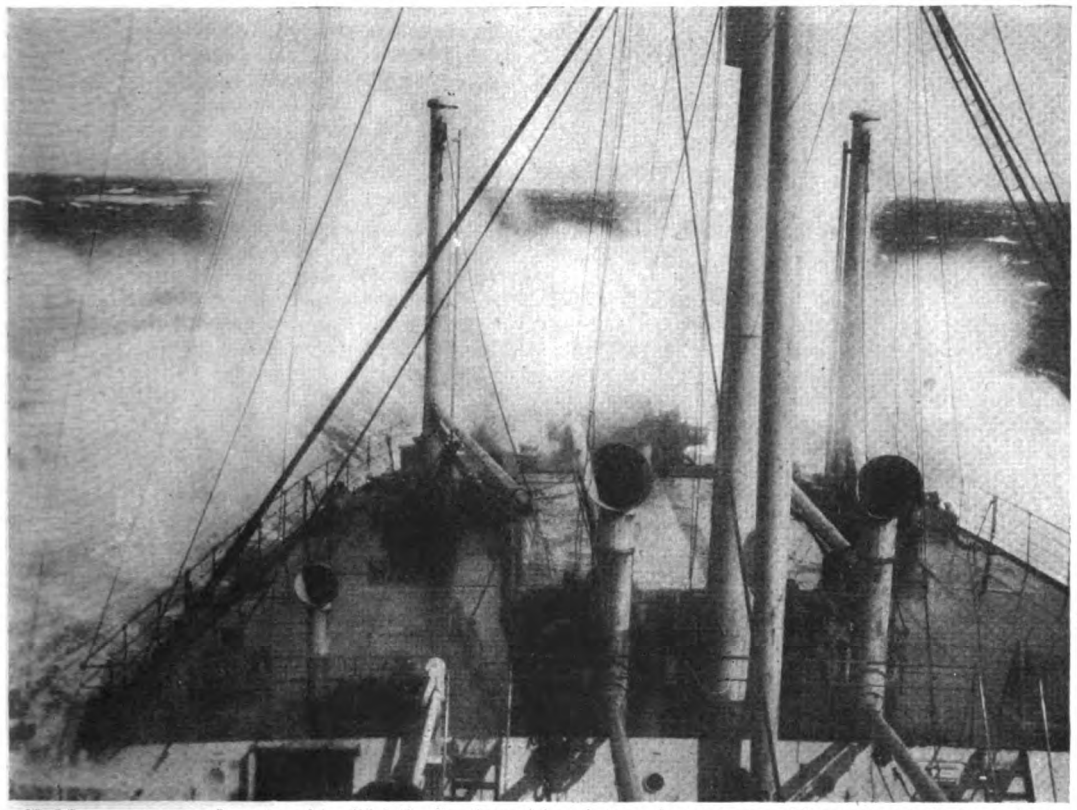
The 6th edition of the well-known book by S. W. Barnaby on marine propellers has recently been published by E. & F. N. Spon, Ltd., of New York and London.

SMALL STEAMER CHANGED TO DIESEL POWER

Some time ago a Danish Shipowning firm ordered a steamer of 1,400 tons d.w.c. from the Flensborg Shipyard. The type of machinery has just been changed by her owners, and a 350 shaft h.p. Holeby Diesel-engine is being installed.

"MADAL" A CONVERTED LIGHTER

A sea-going lighter has been converted to Diesel power under the supervision of the British Corporation by the N. V. Scheepsw. "Deklup" for Norwegian owners. The name of this vessel is "Madal" and she is 180 ft. long by 35 ft. in breadth, and is now propelled by a Polar two-cycle type Diesel engine. She will be used on the East African Coast and river service. Trial trips were recently run in Holland.



Maiden voyage of motorship "Afrika." Smashing into a heavy sea. The voyage is described on page 127

MOTOR TANKERS "WOTAN" AND "LOKI"

An agreement now having been reached between the U. S. Shipping Board and the Reparation Committee, the Diesel-driven tankers "Wotan" and "Loki" have been transferred to the Standard Oil Co. of N. J., who is the rightful owner of these ships.

SWEDISH GOVERNMENT SUBSIDIES FOR MOTOR-VESSELS

A loan of 400,000 kroners has been requested from the Swedish Government by the Rederi A/B Gloria of Helsingberg, Sweden, towards payment of a 2,650 tons motor-driven auxiliary sailing-ship recently purchased from America.

The Blankaholms Sagverks A/B (a sawmill and lumber concern) has applied for a loan of 300,000 kroner towards purchasing a motorship of 1,100 tons d.w.c. ordered from a Vasterik shipyard.

WARSHIP TO MERCHANT MOTORSHIP

Acceptance trials of the "Adolf Sommerfeld," recently converted in Germany from a warship to a cargo-carrying motorship, were made on October 11th with the result that a speed of 13 knots was made light, instead of 12 knots anticipated, the fuel-oil consumption working out at 0.44 lb. per shaft h.p. In view of the fact that the Diesel engines are of the high-speed submarine type, the results may be considered very good indeed. Each engine has six cylinders and develops 800 shaft h.p. She was illustrated last month.

We understand that the cost of reconstructing the vessel was only 3,000 marks per d.w. ton ($42.00 at current exchange). Each of the engines was illustrated on page 25 of our January issue has six cylinders, 17.75 inch diameter by 16.53 stroke, so that the bore is greater than the stroke, which is very unusual with Diesel engines installed in merchant vessels. Of course, in this case there is a special reason, inasmuch as the engines were originally intended for submarines. The vessel has been registered in Danzig.

MOTOR LINERS FOR HAMBURG-AMERICAN CO.

It has been reported that the Hamburg-American Line are shortly placing two 525-ft. emigrant motor-liners on the Hamburg-New York service, and that these ships will be propelled by submarine-type Diesel engines at 14 knots.

WERKSPOOR 3,300 i.h.p. DIESEL ENGINE

Some months ago we stated that designs have been prepared for an eight-cylinder Werkspoor merchant-marine Diesel-engine developing 3,300 i.h.p. at 100 R. P. M. We hear that its length is 48½ ft.

WORLD'S MOTORSHIP TONNAGE UNDER CONSTRUCTION

According to a report recently issued by Lloyds, there are 450,000 tons of motorships under construction in the world, excluding a considerable number building in Germany. This does not inclue motorships on order, that are not yet laid down. We believe that the world's total exceeds a million tons.

CONSUMPTION TEST AFTER NINE YEARS SERVICE

Recently a useful consumption test was made of the veteran single-screw Werkspoor Diesel-engined tanker "Juno" and a fuel-consumption of 0.350 lb. per i.h.p. hour was recorded. The "Juno" was placed in service in 1912 and has one engine of 1400 i.h.p.

SEVEN MORE MOTORSHIPS ORDERED FROM THE NAKSKOV YARD

Four additional motorship are now under construction at the Nakskov Shipyard to the order of Danish shipowners. It may be remembered that this yard built the 9.000 tons motorship "Orient" and the 4,800 tons motor-tanker "Mexico". The first of the additional four vessels is of 13,250 tons d.w.c., a sister-vessel of the East Asiatic Company's motorship "Afrika," and is to the order of the same concern.

The East Asiatic Company, in addition, have ordered from this yard a coastwise motor-passenger liner of 3,800 tons d.w.c., as well as a motorship of 1,000 tons d.w.c. known in the yard as "Number 5."

Furthermore, the United Shipping Company of Copenhagen, owners of the two large motorships "Oregon" and "California" have a motorship of 7,000 tons d.w.c. under construction at the Nakskov Yard. All these vessels will be engined by Burmeister & Wain, with the exception of the 1,000 tons boat which will have a Holeby Diesel-engine.

PERFORMANCE OF THE "KATHERINE"

The Bolinder-engined auxiliary motorship "Katherine" has now run 45,396 nautical-miles, and her engines have only stopped at sea for a total of 7 hrs. 30 min.

Maiden voyage of motorship "Afrika." The tail-end of a "big one" washes the decks

"FRITZ" RE-NAMED "ASSYRIAN"

The Blohm & Voss-built double-acting Diesel motorship "Fritz" has been re-named "Assyrian" by the Ellerman Line, who recently purchased her from the British authorities. She is one of the vessels delivered by Germany under the Armistice terms, and her engines were recently described in "Motorship."

NEW COASTWISE MOTORSHIP

A small cargo coastwise motor-vessel named "Ben Truman," of 125 tons d.w., has been launched by James Pollock & Sons, to the order of Messrs. Truman, Hanbury & Buston Co. of Burton-on-Trent, England. Two 80 b.h.p. Bolinder oil-engines are installed.

COASTWISE MOTORSHIP "ADMIRAL VERNON"

A 340 tons d.w.c. Bolinders oil-engined steel coastwise motorship named "Admiral Vernon" was recently launched by Jas. Pollock & Sons Co. at the Faversham Yard, England, to the order of Wm. Vernon & Son, the well-known millers of Liverpool.

THE COMING OF THE DIESEL ENGINE

The greatest development in marine-engineering is the almost universal extension of engineering shops for the construction of Diesel-engines. This extends right up the European seaboard. The wide adoption in the near future of the oil engine on a very comprehensive scale is regarded almost as a certainty, and one wonders sometimes whether owners, who almost as a matter of routine are ordering reciprocating steam-sets, quite realize the nature of the revolution that is going on around them. — *Shipbuilding & Shipping Record (London).*

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Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed)

FOUR-CYCLE VERSUS TWO-CYCLE DIESEL ENGINES

To the Editor of "Motorship,"
Sir:

We should be much obliged if you would publish in the next number of your valued paper, under "Our Readers' Opinions," the following short reply to the letters of Mr. Shaw and Mr. J. Muysken.

We note with pleasure that Mr. Shaw and Mr. Muysken, in their letters in the October and December numbers of "Motorship," examine our statements in an objective manner, and we are glad that Mr. Muysken acknowledges that our opinions are correct, if the four-cycle and two-cycle engines are constructed on similar lines.

Concerning the possibility of higher speeds for the four-cycle engines, a four-cycle engine running at the same speed as a two-cycle engine of the same power, has in consequence of its longer stroke (about 30 per cent more) a greater piston speed, and therefore, in our opinion, should not be run at a higher speed than a two-cycle engine.

If the four-cycle engine has any advantages over the two-cycle engine because of the maximum pressures occurring only every second revolution, these advantages are to a large extent counterbalanced by the higher speed of its piston and driving gear, even when the four-cycle engine is running at the same number of revolutions as the two-cycle engine.

When we support the adoption of low speeds for marine engines, we are thereby only meeting the wishes of ship-owners, who prefer to rely on the good experience they have had of slow-speed steam-engines and of propellers turning at a low rate. The general tendency at present is for new motorships to be fitted with propellers of a slower speed than formerly was the case.

We think it only right to support these efforts when designing Diesel engines for the propulsion of ships, and for marine engines we recommend much lower speeds than we have used with success in the many large stationary two-cycle installations we have constructed.

Mr. Shaw's remarks concerning the two-cycle motorship "Hamlet" are not suitable for Sulzer engines, and the conclusions he draws are therefore quite erroneous. Our two-cycle engines work continuously, not with a mean indicated pressure of 4.4 Atm., as he assumes, but with approximately 6.5 to 7.0 Atm., and we, of course, undertake to fully guarantee these figures. By inserting this mean indicated pressure, it is at once seen that the comparison Mr. Shaw makes with a four-cycle engine does not hold for a Sulzer two-cycle engine.

Yours faithfully,
SULZER FRÈRES,
Société Anonyme.

Winterthur,
Dec. 23, 1920.

TWO-CYCLE VERSUS FOUR-CYCLE

To the Editor of "Motorship,"
Sir:

Having had considerable experience with various types of marine Diesel engines for the past eight years, I have followed with interest the correspondence in "Motorship" between Messrs. Sulzer and Messrs. Werkspoor, regarding size and weight of 2 and 4-cycle engines, and I think it would be of greater utility to the public generally if the arguments for and against the two types, by the most prominent representatives of the proposed parties be brought more before the public.

Although not being a party to it myself, I am interested enough to think that the question should be fought out honestly. I have made a careful comparison of the hypothetical Sulzer engine and with the engines of the "Salerno," on page 1094 of your December issue.

The scale of this drawing can easily be computed, the size of the "Salerno" engines being given. Taking the ratio of the distances between centres and the cylinder-bore to be about the same for both engines, we find that the bore of the Sulzer engines is roughly 18 inches, and their ratios of stroke to bore being 1.6, as stated in their letter, a stroke of 29 inches.

A two-cycle engine of this size, with four cylinders, will, at 125 r.p.m., taking a mean-pressure of 75 pounds and a mechanical efficiency of 70 per cent, develop 625 shaft h.p., whereas the "Salerno" engines develop 1,040 shaft h.p. at the same speed and with the same mean-pressure. The diagram illustrating the Sulzer letter is therefore absolutely misleading, and I think it a pity that a diagram of this species be published without criticism.

My opinion is that the Sulzer firm are fighting a losing case, when they have to resort to measures as these, and I doubt very much whether their English licensees will be responsible for such.

Yours very truly,
J. W. WODARD.

Dec. 17, 1920.
3, Osborne Road,
Newcastle-on-Tyne, England.

THE MOTORSHIP "PENDRECHT"

To the Editor of "Motorship,"
Sir:

In the October issue of your paper you have given a description of the Italian M.S. "Ansaldo San Giorgio I," and we can only admire the interest and thoroughness with which you have personally gone into this matter.

There is, however, one little error, which has nothing to do with the article itself, but which we would rectify. While going down to Philadelphia on the "Ansaldo San Giorgio I," you say that you passed the Kromhout-engined motor-tanker "Pendrecht" of Holland. That vessel, however, is equipped with two 320 b.h.p. Bolinder engines, which we have only wanted to point out to you.

Yours very truly,
J. & C. G. BOLINDERS CO.

Stockholm, Sweden.
December 17, 1920.

DIESEL-ENGINE FLEXIBILITY

To the Editor of "Motorship,"
Sir:

On reading the December issue of a London publication, we noted the reports on the results of trials at Sunderland, of Doxford's first 3,000 h.p. oil-engine, 77 r.p.m. being the normal speed of this engine when developing 3,000 b.h.p., the same can run continuously at a low speed of 16 r.p.m.

We beg to send you herewith diagram referring to one of the several trials of our normal type of 1,100 b.h.p. powered engines, fitted on board the motorships of the "Societa Nazionale di Navigazione," which shows how this engine has run from a maximum of 150 r.p.m. down to a minimum of 40 r.p.m., the variation being quite of the same order as the one achieved by the Doxford engine. Very noteworthy is the fact that these figures relate to trials in our Works with dynametric-brakes, and, of course, with practically no resistance on the shaft, owing to the low speed.

In fact, in the other diagram, referring to sea-trials of another engine of the same type and power, can be noted how revolutions down to 35 p.m. were obtained.

On page 250 of the November issue of the same journal, in a report on the operation of the M.V. "Narragansett," there is informed that the Vicker's internal-combustion engines are very flexible, owing to the fact that the revolutions from normal speed of 117 r.p.m. are reduced to 48 per minute. As it can be easily seen, the variation, in this case, is less extensive than for above-mentioned "Ansaldo San Giorgio" type.

The flexibility of these engines is officially stated, with their regularity and reliability, in many reports of the Technical Bureau of R. Corps of Naval Constructors of the Navy, in Genoa.

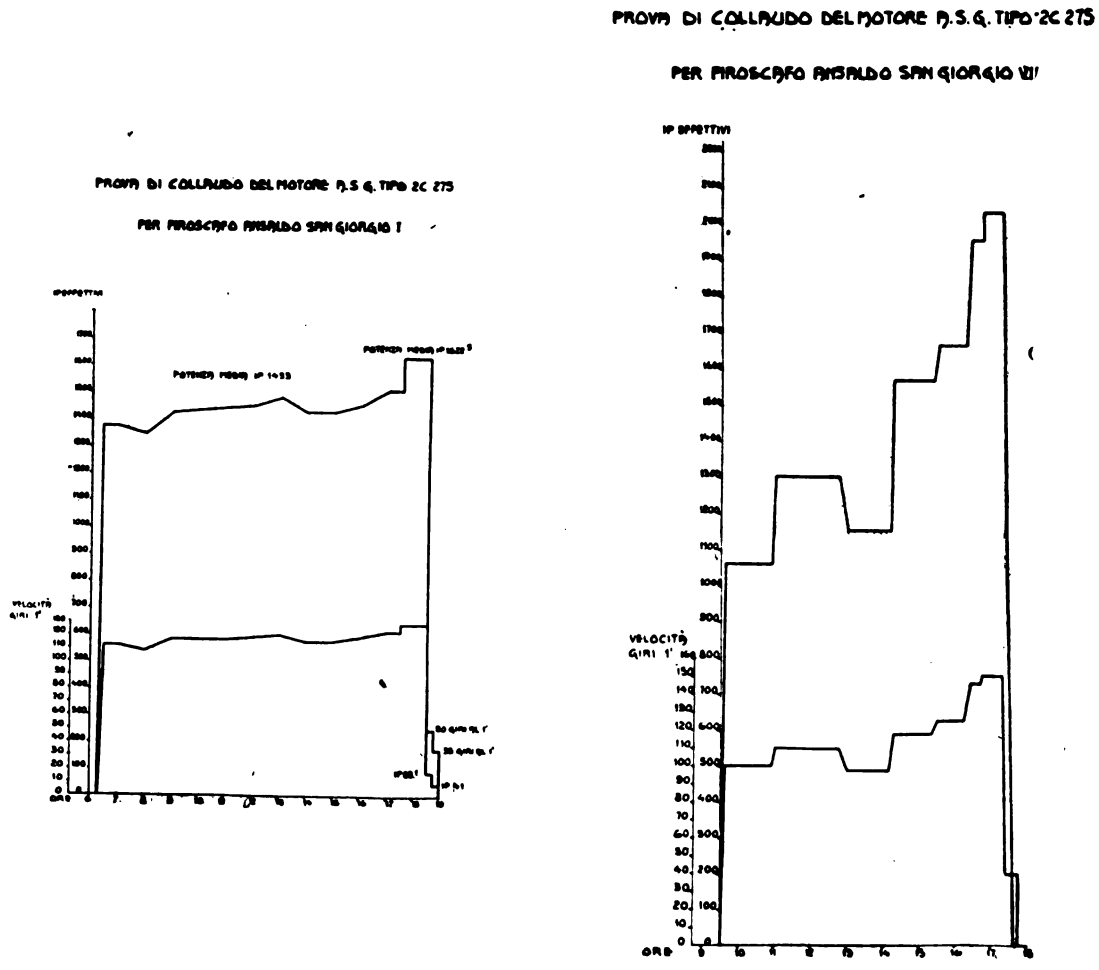
We shall be much obliged if the above remarks, as well as the diagrams, should be published also in a next number of your so appreciated periodical.

Yours very truly,
Z. M. TORRELO, Director.

Ansaldo San Giorgio, Ltd.
Torino, Italy.

TWO MORE MOTORSHIPS CONSTRUCTED UNDER SECTION TWENTY-THREE OF THE MERCHANT MARINE ACT

Approval has been given by the U. S. Shipping Board for the construction of the motor-tankers "F. H. Hillman" and "Charlie Watson," of 5,140 tons d.w. and 2,300 tons d.w., respectively, under the provisions of Excess-Profits Tax Exemption of Section Twenty-three of the Merchant Marine Act. Both vessels are owned by the Standard Oil Company of Calif.


PROVA DI COLLAUDO DEL MOTORE P.S.G. TIPO 2C 275
PER PIROSCAFO ANSALDO SAN GIORGIO I
PROVA DI COLLAUDO DEL MOTORE P.S.G. TIPO 2C 275
PER PIROSCAFO ANSALDO SAN GIORGIO VII

Diagrams illustrating Ansaldo San Giorgio Co.'s letter

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Injection and Combustion of Fuel-Oil

Experiments with Solid-Injection and Air-Blast in Marine Diesel-Engines

By Engr. Commander C. J. HAWKES, R.N.(Ret.)*
Professor of Engineering, Armstrong College, Newcastle-upon-Tyne

[Owing to great pressure on space, we have been obliged to hold over this interesting article until this issue, as stated in our January number.—*Editor.*]

INJECTION of fuel-oil in Diesel engines is of the utmost importance, especially in the case of engines of comparatively high speed. In dealing with this subject references are made to experiments which have been carried out at the British Admiralty Engineering Laboratory in connection with development for naval purposes. The more general method of injecting fuel-oil into a Diesel engine is by the use of compressed-air, but considerable advance has been made with the, so-called, solid-injection system. It is now generally known that nearly all British submarine engines are fitted with the solid-injection system—and the credit for this development is due to Vickers, Ltd.

With the air-injection system a definite quantity of fuel-oil is pumped into the fuel-valve casing, and when the fuel-valve is lifted off its seat compressed-air, provided by a high-pressure air-compressor, blows the fuel-oil into the cylinder in a very finely divided state. In the case of the solid-injection system no air-compressor is required. The fuel-pump raises the oil in the fuel-valve casing, and in the system generally, to a comparatively high pressure, and when the fuel-valve is lifted off its seat the requisite quantity of oil is forced, by its own pressure, through a number of small holes in the sprayer—which causes the oil to be split up into a mist. It is proposed to refer in the first instance to experiments carried out with the solid-injection system and then to certain experiments with the air-injection system.

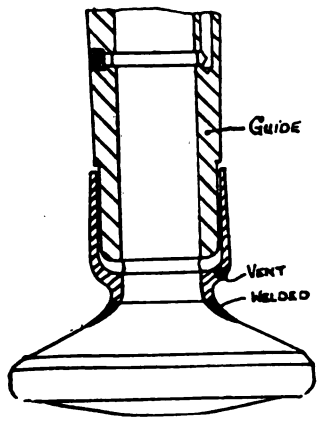

Fig. 1

The single-cylinder four-stroke engine used for the solid-injection tests was the first engine installed in the Admiralty Engineering Laboratory. This engine, which is fitted with a piston of aluminium alloy, has a cylinder diameter of 14½ inches, stroke 15 inches, and develops 100 b.h.p. (nominal) at 380 r.p.m.

The solid-injection fuel-valve used during most of the experiments detailed was of the direct-lift type, i. e., the fuel-valve spindle, which passed through a gland, was operated directly by the fuel-valve lever. The instant of injection of the fuel was adjusted by means of the timing-gear which altered the position of the fuel cam-shaft in relation to the crankshaft. The fuel-pump used during the tests was of bronze and the suction and delivery valves were of hardened steel. The fuel-pump glands were packed with Palmetto packing.

Owing to the use of very small holes in the sprayer it is imperative that the oil should be thoroughly strained, and strainers are consequently fitted on the suction side and also on the discharge side of the fuel-pump between the pressure-gauge and the fuel-valve. The fuel used during all the solid-injection tests referred to was shale fuel-oil having a specific gravity of about 0.86 at 60° F., flash point 220° F. (close test) and a viscosity of 43 sec. at 70° F.

The fuel-tank, 18 in. in diameter and 5 cu. ft. capacity, was arranged with a narrow neck 3½ in. in diameter in which a point gauge was fitted. At the commencement and at the end of each fuel-consumption test the level of fuel-oil in the tank was arranged so that the gauge point in the neck was just visible; consequently the weight of fuel-oil poured into the tank was the fuel-consumption during the test. The fuel-oil was conveyed to the tank by means of a can. This can was carefully weighed within half an ounce, by means of a standard balance, when it was full of oil and again when a quantity of oil had been poured into the tank.

The power developed by the engine was absorbed by a Heenan and Froude dynamometer. The counter readings and other records were taken every 15 minutes. In some cases only half-hour tests were made but, even with such short

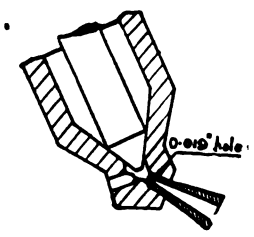

Fig. 2

runs, with the apparatus used and with the engine at working temperatures the records were for all practical purposes accurate. The results given are the means of not less than two tests carried out under the same conditions. In all cases, with the exception of a few runs at low powers, the initial, or maximum, pressure was adjusted by means of the timing gear to about 630 lbs. per sq. in. before commencing a test. The compression-pressures used during the tests are shown in the tables of results. Throughtout the principal tests the jacket, etc., cooling water was kept at a mean temperature of about 80° F.

On account of the situation of the laboratory it was necessary to fit an exhaust pipe about 180 ft. in length. The engine exhausted into two silencers fitted with water-sprays and consequently steam was produced in the exhaust-pipe which made it difficult to ascertain the condition of the exhaust with any degree of accuracy. The drainage water from the first silencer was, however,

TABLE 1.—RESULTS OF TESTS WITH VARIOUS SPRAYERS, &C.

Ref. letter of Tests	R.P.M.	B.H.P.	Opening of Fuel Valve before t.d.c. Degs.	Fuel Oil. Lbs. B.H.P.-hr.	Fuel Oil. Press. lbs per sq. in.	Fuel Valve. Sprayer. No. of holes.	Fuel Valve. Sprayer. Diam. of holes.	Fuel Valve. Roller Clearance. Inches.	Compression Pressure lbs. per sq. inch	Remarks
A	380	100·1	20	0·45	4,000	5	0·019	0·030	460	
B	381·5	101	10·5	0·42	4,200	5	0·016	0·072	460	
C	377·5	99·4	11·5	0·42	4,500	5	0·016	0·095	460	
D	380	100	19	0·47	4,300	5	0·016	0·003	485	Steel plates used.
E	382·9	101	23	0·43	3,400	5	0·016	0·003	380	Compression reduced to 380 lbs. per sq. in.
F	380·3	100·3	12	0·42	5,600	5	0·016	0·090	380	
G	380·8	100·4	15	0·49	3,700	5	0·016	0·003	490	Piston top covered with plates. Compression increased to 490 lbs. due to addition of plates.
H	380·3	100·2	8	0·46	5,600	5	0·016	0·100	490	Do. do.
J	378·4	99·8	8½	0·47	5,700	5	0·016	0·100	490	Steel plates. Fuel oil heated to 400 deg. Fahr. on pressure side.

Table 1

allowed to pass over a glass plate painted white on the under side, and it was found that by this means the condition of the exhaust could be readily ascertained and the presence of even a smaller quantity of carbon in the exhaust-gases was immediately detected. In the results given, therefore, the condition of the silencer drainage water is recorded. The aluminium-alloy piston, which was fitted with six narrow cast-iron rings, was lubricated with the same oil as was used for bearing lubrication. The exhaust valve of the experimental engine is water cooled.

During tests which were previously made with this engine it was found that the exhaust-valve had a tendency to stick even after a comparatively short period of working. When examined it was found that the clearance between the valve spindle and its guide was always filled with a hard carbon deposit and it was decided to grind the spindle parallel and fit a deflector, as shown in Fig. 1, arranged so that when the exhaust-valve opened the spindle was protected from the rush of exhaust-gases. This deflector was found to be effective in the experimental engine, and since it has been fitted there has been no sign of sticking of the exhaust-valve and the spindle has always been free and clean when removed for examination. The valve spindle is lubricated by means of a mechanical lubricator.

Experiments were carried out with the object of ascertaining the effect of varying the number and size of the holes in the solid-injection sprayer.

Before commencing these experiments tests were carried out with the single-cylinder engine at 100 b.h.p. and 380 r.p.m. with a sprayer provided with five holes 0.019 in. in diameter. This sprayer was similar to the sprayers fitted in submarine engines in 1914. It had previously been found that better results could be obtained by increasing the pressure in the system, and Test A, Table I., was therefore carried out with a fuel pressure of 4,000 * lbs. per sq. in. (gauge). The fuel-consumption was 0.45 lbs. per b.h.p.-hour, but

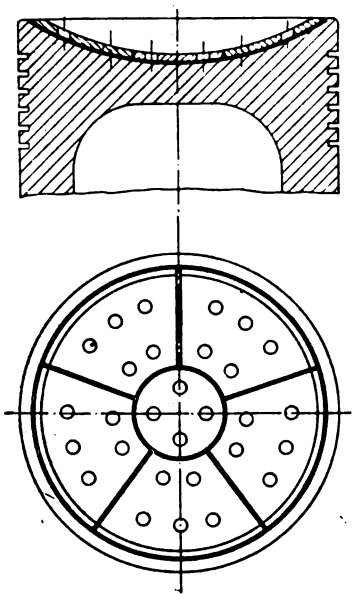

Fig. 3

it must be remembered that the experimental engine has only a single cylinder and it is fitted with a camshaft driving mechanism which was originally made for a multicylinder engine of the same design.

It was thought that slightly better results might be obtained if the fuel sprays were passed over a heated surface and a sprayer was therefore made so that each of the five 0.019 in. holes was surrounded by a steel trumpet expanding from 1/16 in. to 3/16 in. in 3/4 in. Each trumpet was driven into the sprayer and caulked, and the 0.019 in. holes were drilled in their ends as shown in Fig. 2. The fuel-valve in the experimental engine was inclined to the axis of the cylinder, and owing to this inclination a large portion of some of the trumpets had to be cut away to allow the fuel-valve to enter the cover. The modified sprayer was tested in the engine, but the maximum b.h.p. obtained was only 65. When the valve was removed and examined it was found that the interior of each trumpet was quite clean and bright, but there was a considerable carbon deposit on the external surface. There was no doubt that the jets of oil had been striking the inner surfaces of the trumpets, and it was decided to ascertain the effect of increasing the size of each

* North East Coast Institute of Engineers and Shipbuilders. Nov. 26, 1920.

* The pressure in the system during all the experiments referred to in this Paper was increased as necessary by increasing the clearance between the roller carried by one arm of the fuel valve actuating lever and the fuel cam.

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trumpet so that it expanded from 1/8 in. to 5/16 in. in 3/4 in. This alteration resulted in increasing the power to 95 b.h.p. at 380 r.p.m., but after 40 minutes running the power dropped to 90 b.h.p. On examining the trumpets it was evident that the jets had again been striking the sides and dribbling had occurred. The color of the trumpets also indicated that they had been comparatively cool and had not reached a red heat. It was decided, therefore, to proceed no further in this direction.

Several tests were then made with sprayers provided with holes smaller than the standard 0.019 inch. As there were, at that time, no suitable drills available, the small holes were made by drilling holes about 0.019 inch diameter, caulking them over, and then opening them out again to the size required with a fine tapered reamer. The holes were, therefore, 0.019 inch in diameter with a knife-edged orifice of slightly smaller diameter. Fairly good results were obtained with a sprayer having five 0.015 inch holes, but a sprayer provided with five 0.015 inch holes, was not promising. The best all-round results were obtained with a sprayer having five 0.016 inch holes, equally spaced. Tests B and C, Table I., give the results obtained with the 0.016 inch-hole sprayer. It will be seen that in each case the fuel-consumption is appreciably less than with the 0.019 inch-hole sprayer.

At this stage it was decided to ascertain the effect of fitting steel plates to the top of the aluminum-alloy piston. Five insulated steel plates were therefore fitted, each 2½ inches by 2½ inches by ⅜ inch thick, in positions such that the fuel-sprays would strike them. The fitting of these plates increased the compression-pressure by 25 lbs. per square-inch. The results obtained are shown in Test D, Table I. It will be seen that the effect of the plates was to increase the fuel-consumption. When the plates were examined it was found that they had been running at an appreciable temperature and some were blistered. As it was thought that the sprays had not been striking the plates fairly it was arranged to fit larger plates.

Before fitting the large plates the compression was reduced to 380 lbs. per square-inch and tests were carried out with the sprayer provided with five 0.016 inch holes. Test E, Table I., gives the results with a fuel pressure of 3,400 lbs. per square inch and Test F, Table I., gives the results with a fuel pressure of 5,600 lbs. per square inch.

Six insulated steel plates were then fitted to cover the piston, as shown in Fig. 3, and tests carried out. The results are given in Table I, Tests G and H, and it is clearly shown that the plates did not assist the combustion. The fuel-consumption per b.h.p. in Test H was 0.46 as compared with 0.42 obtained in Test F under similar conditions as regards fuel-valve roller clearance and fuel-injection pressure, but without the plates.

It was then decided to increase the temperature of the fuel-oil on the delivery side of the pump, and this was done by passing the fuel-oil through a steel-coil placed in the exhaust-pipe. The temperature obtained, recorded by a thermocouple in the circuit, was 400° F. No improvement resulted. (See Table I., Test J.)

When the plates were removed it was found that they had been very hot in places, they were generally free from carbon deposit, and although they were not blistered there were distinct signs of erosion where the fuel-jets impinged. The unsatisfactory results were certainly due to delayed combustion—which was clearly shown by the indicator cards and the exhaust temperature. The Author was of opinion that possibly the results obtained were to a certain extent due to some of the particles of fuel-oil assuming the spheroidal state on striking the hot piston, thus delaying vaporization and combustion. Some simple experiments, which it was hoped would throw some light on the matter, were made by allowing heavy petroleum oil to fall in drops through a distance of about 6 inches, at the rate of one drop per second, on to a heated steel-plate. No temperature measurements were taken but at a barely visible red heat in daylight (say 930°F.) there was no sign of the spheroidal state. The drops did not break up, but carbon deposit was left by each drop and accumulated—and this was difficult to burn off at a bright-red heat. At a full cherry-red heat (say, 1,470° to 1,560° F.), each drop broke into six or eight smaller round drops, which did not "run" as water in the spheroidal state does, but they scattered over a circle about 1 inch in diameter and remained momentarily where they fell Hardly a trace of carbon was formed and the oil appeared to crack almost at once into heavy vapours and gases. Texas oil gave very similar results.

(To be continued in our March issue)

More Thought on the Diesel Oil-Engine

Possibilities of Improving Methods of Fuel-Injection

BY Z. WIRT

MUCH has been published regarding the attitude of American shipowners and shipbuilders toward the Diesel oil-engine and it is fair to assume that they are at least awake to the needs of the situation. Altho, it would seem that constant republication of such articles with variations and additions in the light of progress made until their full object has been attained and results secured, might serve a useful purpose.

The possibilities for an American designed Diesel-engine conforming to proven established practice in all essentials of standard construction, are great. The elimination of complicated mechanical movements for valve operation, accessibility of moving parts requiring lubrication, examination, adjustment and repair affords a promising field for improvement as does the design of parts so that they are interchangeable for either right or left hand engines; thus saving production and erection cost.

On the important question of efficiency much of the loss may be charged to the initial direct thrust at the start of combustion, the crankpin and shaft being in direct line, while the point in the revolution when the leverage is greatest, is near that when injection of fuel ceases, but there seems no practical way to overcome this condition until the internal-combustion oil-turbine becomes a practical reality, which seems a long way in the future.

The effect of design and type upon installation cost and efficiency can not be expected to produce much result above the present percentage of efficiency until such means are employed as will give quicker and more complete combustion of the injected fuel, at the same time not increasing complication and loss of efficiency thro friction or in other ways. Perfect combustion can not take place without sufficient oxygen within the combustion-chamber to balance the fuel injected as it enters from the valve nozzle. Even where the amount of oxygen is sufficient, a question arises as to how perfectly combustion takes place owing to the rapid expansion or explosion of the first sprayed oil-fuel entering the compression-chamber forcing back the oxygen from coming in contact and mixing with the atomized fuel-oil entering later. Also, what effect the rapidly increasing space in which the combustion takes place, has upon combustion, for as the piston recedes on the power stroke there is a rapid increase of space behind the piston which naturally permits the unused oxygen content to move away from the point of fuel injection rather than toward it, and it would seem that combustion would be slowed up accordingly resulting in its continuing to the end of the power stroke which is practically what does take place, resulting in lower mean pressure.

This might seem an unwarranted speculation when dealing with time as related to an explosion or combustion such as takes place in the compression space of a Diesel engine; but, obviously there is a time of beginning, whether "sprayed" or mechanically injected, and as the beginning of the combustion is coincident with the commencement of fuel-oil entry, and the absorption of oxygen also being simultaneous, the setting-up of a rapidly expanding barrier of flame around the injection-nozzle retards the access of oxygen further away from the spraying-nozzle, and the increasing pressure of the expanding gases has a tendency to retard the spraying and distribution of the finely divided atoms of oil which would otherwise give the proper balanced mixture.

More than one fuel-valve would have a tendency to better mixing of sprayed fuel with oxygen, but multiplies mechanical difficulties in valve operating-mechanism, so it is doubtful whether the improved results obtained outweigh the disadvantages. Much might be looked for, to improve Diesel engine efficiency, from a better designed valve-nozzle whereby the oxygen is either permitted more continuously complete access to the sprayed oil, or air injected into the atomized oil.

It is difficult to determine accurately conditions, causes and effects that obtain within the cylinder walls of a Diesel engine during the several strokes, but it is reasonable to assume that during the compression stroke of a four-cycle engine, aside from the raise in temperature and pressure there is very little turbulence and that the increased pressure would have a tendency to decrease such agitation within the compression space. During the combustion period and explosion stroke the initial density of highly-compressed air would seem to have a tendency to retard atomization or the reduction of the fuel into a fine mist. Agitation by means of admission of compressed-air from a high-pressure supply would certainly cause better combustion and it is conceivable that the closer such inlet of air is to the fuel-oil inlet the better mixing and better combustion.

Frictional and mechanical losses are not likely to be reduced to an appreciable degree, while very little can be hoped for in greater thermal efficiency of heat units as now generated, therefore it is to more perfect combustion resulting in more thermal units being created that anything approaching increased efficiency may be looked for. The utilization of heat from exhaust-gases may be made for purposes of heating living quarters of ships advantageously.

However interesting and vital the possibility of improved efficiency in the Diesel engine may be, the question that transcends all others in importance is how to move American engineers, ship-builders and shipowners to a full realization of the needs of the situation and get them to abandon the un-American position of holding back.

S.S. "MOUNTJOY" CONVERTED TO MOTOR POWER

Before the days of Diesel motorships—in 1898, to be exact—Burmeister & Wain, of Copenhagen, built the steel steam-vessel "Mountjoy," ex "Rudolph," 214 tons gross. This little ship was recently fitted with twin-screw Vickers-Petters surface-ignition oil-engines, and is now owned by Salterns, Ltd. (G. Castle, Manager), Parkstone, Dorset, England.

LEROUX & HEUZEY OPEN BRANCH OFFICE

We have been advised that Leroux & Heuzey (ex-Prenthout, Leblond & Leroux) have opened a branch office at 48 Rue des Petits Champs, Paris, which will be under direction of Mons. J. Decoudier, Chevalier de la Legion d'Honneur, Croix de Guerre. It may be remembered that Prenthout Leblond & Leroux is the enterprising shipowning firm who had the courage to build the 10,500 tons displacement Diesel-driven steel auxiliary sailing-ship "France." Their new branch office will deal with the charter, sale and purchase of all merchant ships.

NEW AMERICAN MARINE OIL ENGINE

With a view to entering the marine market a 100 b.h.p. vertical oil-engine has recently been designed and constructed by the Standard Fuel Oil Engine Company at Bucyrus. The first engine will be used for stationary purposes, but from the same it is expected that a marine engine will be developed. It is a two-cylinder, two-cycle type machine and the present tests are showing mechanical efficiency of 80% and better—the work being distributed as follows:—

To Scavenging Pump	3.2%
To Compression	6.4%
To Mechanical Losses	10.4%
To Useful Work	80.0%

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MOTORSHIP "GLENAPP" LEAVES WITH FULL CARGO

The 14,500 tons d.w. British motorship "Glenapp" of the Glen Line recently left London on a voyage to the Far East with full cargo and with full passenger booking of one dozen first-class passengers. The "Glenapp" is the second motorship of this name—the first now being known as the "Aba" and is owned by the Elder Dempster Line.

It will be noted that the majority of motorships are obtaining full cargoes, while many steamships are laid-up. Incidentally we will mention that the passenger accommodation of the "Glenapp" is booked beyond next September. Her average loaded speed is 12½ knots and she only burns about 18 tons of oil per day.

NEW SPANISH MOTORSHIP

Trials will shortly be run of the motorship "Alca" recently completed at Gijon, Spain. She is of 450 tons d.w.c. and is propelled by a 150 b.h.p. Diesel engine.

CONVERT OUR STEAMERS TO DIESEL POWER —SAYS FRANK MUNSON

"The uneconomical steam-engines and boilers must be removed from the Shipping Board's steel ships, and replaced with Diesel-engines or Diesel-electric drive, or we will be unable to compete with foreign shipping"—said Mr. Frank C. Munson, President of the Munson Steamship Line at the banquet of the National Marine League, held in connection with the Merchant Marine Exposition on January 25th. Further details of Mr. Munson's important advice will be given in our March issue.

CHAS. PIEZ'S ANSWER TO WM. DENMAN

In his testimony to the U. S. Senate Committee investigating the Shipping Board operation, Mr. Chas. Piez, formerly Director General of the U.S.S.B. Emergency Fleet Corp., said:

"Mr. Denman in some recent utterances has dwelt on the advantages of the Diesel engine. I need only say that Mr. Hurley, Mr. Schwab, Mr. Rosseter and all of the men in our technical department were as conscious of that as Mr. Denman. Mr. Schwab's plants were completing a very large two-cycle engine about the time of the armistice, and expected to try it out in one of the Bethlehem ore ships.

"It is well to bear in mind that only a very few engines of a size large enough for even a 5,000-ton cargo-ship, had up to that time been built; that no shops in the United States were prepared to deliver anything over 750 h.p. at that time, and that we could neither wait nor take the chances involved. Mr. Hurley bought two Burmeister and Wain engines immediately after the armistice, for installation in a Fleet Corporation ship."

[We may have some comments to make on Mr. Piez's remarks in our next issue.—*Editor.*]

MOTORSHIPS OF 1920

Eighteen of the largest Diesel motorships completed and placed in actual service during 1920 aggregated 170,990 tons d.w.c. and 62,850 indicated horsepower. This is an average of 9,499 deadweight tons per ship, and an average horse-power of 3,492, according to recent launches and vessels on the ways, the tonnage for 1921 will be five times the amount by December 30 next.

NEW MOTORSHIP COMPANY FORMED

For the purpose of taking advantage of the present remarkable development in the motorship field, and on account of the heavy demand for oil and for mediums of oil transportation, a new company has been incorporated under the name of the Emerald Motorship Company, 25 Broad Street, New York City. According to advices received, the directors have decided upon a Diesel-driven tanker as their first vessel.

The policy of this company, as outlined to us, is an obvious indication that the men behind it are progressive and far-sighted, and the adoption of economical motorships, particularly during the time of steamship depression, is greatly in favor of its success in the undertaking, and their enterprising action should be noticed by prominent American oil-companies, who so far have been slow in adopting the Diesel-driven tanker for the transportation of oil in bulk.

No doubt other shipping men will, before long, adopt motor-tankers for the purpose of transporting their own bunker-oil unless oil-companies endeavor to reduce the transportation charges by propelling their tankers with the most economical power available. Meanwhile, the Emerald Motorship Company will have a considerable advantage in competition in the transportation of oil if they are able to complete several tankers at an early date. So, we cannot but wish them success in their new venture.

INSURANCE ON DANISH DIESEL MOTORSHIPS

Reference is made to the insurance of motorships in Denmark in the first issue of the Bulletin of the American Bureau of Shipping. Their Copenhagen representative states that no difference in insurance rate is made between coal-burners and oil-burners and Diesel-driven ships. But, he gathers the impression that a Diesel-ship is considered the best risk.

The Royal Chartered Marine Insurance Co. quoted a rate of 5 to 5½ per cent, while the De Private Assurandrer quoted a rate of 5½ to 6 per cent; but is considered a very conservative concern. One broker declared he could obtain a lower rate for Diesel motorships than for oil-fired steamers or other vessels of the same age and character, and that the rate on motorships fitted with B. & W. Diesel engines. The rate on Danish Diesel-driven wooden-ships is 1 per cent higher than the steel ship rate, unless the vessel is not first-class.

Wooden auxiliary oil-engined sailing vessels are quoted at 5 per cent higher than full-powered ships.

LAUNCH OF MOTORSHIP "FORMOSA"

An 11,000 tons d.w.c. motorship for the Swedish East Asiatic Company of Gothenburg was recently launched by Burmeister & Wain of Denmark and is the 29th motorship that has taken the water at this well-known Danish yard.

RECORD MOTORSHIP CONSTRUCTION

Considering only an 8-hour shift has been working each day, a remarkable speed has been made with the construction of the 6,000 tons d.w. motorship "Kennecott" building for the Alaska Steamship Co. of Seattle, by the Todd Dry Dock & Construction Company of Tacoma. Exactly 45 days from the date of keel-laying were taken for the launching and no second shift or over-time was used to accomplish this splendid feat. It is expected that the motorship "Kennecott" will be ready for delivery at the end of February, or the early days of March.

DUTCH EAST INDIAN GOVERNMENT TO ORDER MOTORSHIPS IN THE U. S. A.

For the purpose of ordering fast motorships, and to investigate shipbuilding on the Pacific Coast of the U. S. A. on behalf of the Dutch East Indian Government, Mr. R. G. Leegraste recently arrived at San Francisco. The vessels, states Mr. Leegraste, must be powered with Diesel-engines and will be triple-screw boats of 900 tons up, and will have a speed of at least 18-knots—as they will be used for coast-guard and patrol work in connection with opium smuggling traffic into Java. The total amount of money to be spent in the United States will not exceed $4,500,000.

PASSENGER MOTOR-LINER "MAGVANA" LAUNCHED

In our issue of November, 1919, appeared the first details of the motorship for the British India Steam Navigation Co. One of the vessels the "Magvana" was launched on Dec. 24th at Barclay Curle's shipyard in Glasgow. She is of 10,500 tons d.w.c. and has accommodation for 100 first-class and 50 second-class passengers and will trade between London & Calcutta. Twin North British Diesel-engines are being installed, giving the ship a speed of 13½ knots. Complete details will be given in our March issue.

LLOYD'S MOTORSHIP RETURNS

According to Lloyd's recent report there are actually under construction under their supervision in the principal British shipyards a total of 52 motorships aggregating 224,231 gross tons. The total including other districts is 57 motorships aggregating 227,010 gross tons. This is approximately 359,880 d.w. tons. Of these vessels 15 are small coasting craft under 1,000 gross tons each. This refers to Dec. 31, 1920.

Referring to this report "Syren & Shipping" of London states that these figures certainly come as a surprise to all except those most closely in touch with the work which is going on in the shipyards, few people having imagined that the construction of motor-propelled vessels had become such an important part of the British shipbuilding industry, and that these figures emphasize the rapidity with which the new form of propulsion is making a recognized place for itself.

COMPETITION WE WILL HAVE TO FACE

A bill now before the Netherland Parliament will provide a subsidy of one-million guilders per annum for five years to the Holland-South Africa Line.

AMERICAN ENGINES FOR SPANISH SUBMARINES

Twelve 700 b.h.p. Nelseco Diesel engines are being installed in six submarines now under construction at the shipyard of the Sociedad Espanola de Construccion Naval, Cartagena, Spain.

DIESEL ENGINES AT HELIGOLAND

According to a report emanating from a British engineer operating in Germany on behalf of the Allied Governments, some Diesel engines of 1600 b.h.p. generating electric-current for power and lighting in connection with the fortifications of Heligoland run so quietly that if one stands with one's back to the engine it is impossible to say whether or not the engine is running.

OPERATION OF OIL-ENGINED LAUNCHES

Two motor launches named "Louise" and "Asiento" respectively are now in service of the Curacaosche Petroleum Maatschappij of Curacaosche, D. W. I. These boats are both propelled by Bolinder surface-ignition oil-engines and an interesting feature in connection with the operation is that colored men are used for operating the machinery. We recently had the opportunity of seeing a communication from the Curacaosche Company to their associates in New York; namely, the Asiatic Petroleum Co., Woolworth Bldg. The statement says that notwithstanding the colored operators being picked from the ordinary coolie-class of blacks, the oil-engines have never given any trouble. Each boat is 42 ft. long by 11 ft. breadth and carry about 60 passengers each at a speed of 6 knots on a consumption of 1¾ liters of kerosene per mile.

The service consists of short trips of about one mile and the natives generally leave the engines running when moored.

THE ANSALDO-SAN GIORGIO DIESEL-ENGINE

To the Editor of "Motorship,"

Sir:—

To Mr. E. Chiesa's letter re "Ansaldo San Giorgio's Internal Combustion Engines" in your December number, a note is appended that might be rather misleading. We should like to make clear that we have never endorsed any of the remarks made by Mr. Chiesa regarding the Ansaldo-San Giorgio, or Fiat-San Giorgio, Diesel-Engines. On the contrary, our opinion of this two-cycle design is quite the opposite of his, and we have in fact already instituted proceedings against Ansaldo-San Giorgio Ltd. on account of infringement of several of our patents, not only referring to the method of scavenging, but also to constructional details and other working principles.

Yours faithfully,
SULZER FRERES.

Winterthur, Switzerland,
22nd December, 1920.

[The above letter arrived too late for inclusion in our regular "Readers' Opinion" page.—*Editor.*]

CONCRETE AUXILIARY SAILING-SHIP

A German firm, the Kieler Eisenbeton Werft A/G of Budelsdorf-Rendsburg, has launched a 230 tons d.w.c. concrete auxiliary sailing-ship fitted with a 70 b.h.p. surface-ignition oil-engine, to the order of Wentzel & Co. of Lubeck.

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